SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE, PUBLISHED MONTHLY

VOLUME LVII DECEMBER, 1933 NUMBER 6

STUDIES IN BONE SARCOMA

I. MALIGNANT OSTEOBLASTOMATA AS EVIDENCE FOR THE EXISTENCE OF TRUE OSTEOBLASTS

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IN A review of the literature on the histopathology and histogenesis of osteogenic sarcoma, it is found that almost all of the attention is paid to the primary tumor and that little consideration is given to metastases. In textbooks of pathology, mention is sometimes made of the fact that metastases from some of these neoplasms may contain bone. There has also been little attempt to correlate the histopathology of the primary growth with that of the metastases, in regard to new bone formation. A study of the cases of osteogenic sarcoma in the Laboratories of Surgical Pathology of the University of Chicago, and of those in the Bone Sarcoma Registry of the American College of Surgeons would indicate that bone producing metastases from osteogenic sarcomata exhibiting much new bone formation in the primary growth occurs much more frequently than is generally recorded. In fact it is possible that all true osteogenic sarcomata produce ossifying metastases. Furthermore, a consideration of these neoplasms that produce ossifying metastases throws considerable light on the nature of osteogenesis, a process about which there is still considerable controversy.

The classical notion of the existence of osteoblasts or cells, the principle function of which is bone formation, has been seriously questioned by certain authors (Von Korff, Mummery, Spuler, Hansen, Nageotte, Leriche and Policard, Murray, Grieg). According to Murray, "Bone is to be regarded in this conception not as a result of specific cell activity but as a biochemical phenomenon independent of such direct cell participation. Bone production in the adult animal may be regarded as the deposition of calcium compounds in growing granulation tissue incident to the biochemical status of the part." Leriche and Policard state: "The osseous transformation of connective tissue is a phenomenon independent of all cellular action. It is an interstitial and humoral process."

Experimental work on osteogenesis has afforded an extensive literature and yielded important information, but no crucial experiments are recorded in which bone formation has been conclusively demonstrated to be the result of direct cell activity. The conception of the osteoblast as a specific bone forming cell is the result of morphological studies of the early days of microscopic anatomy (H. Muller, Waldeyer, Gegenbaur, etc.). For example, in intramembranous ossification, the rounded or polyhedral cells lining newly forming bony trabeculæ and being obviously included within the bone presented a picture that took little imagination to ascribe bone forming properties to these cells. Leriche and Policard reviewed the entire field of osteogenesis, interpreting the

whole process as a humoral one and not associated with activities of a specific cell, the osteoblast. According to them, bone formation will occur wherever there are sufficient collagenic bundles (upon which calcium may be precipitated), lymphœdema, and supersaturation of the tissue fluids with calcium. Their interpretations are likewise based almost entirely on morphological studies. It must be admitted that there is as much logic to the evidence presented by these latter authors as there is to the older conception of the osteoblasts, if there were no definite proof that such cells exist. However, most of those regarding the humoral conception of bone formation as the correct one have disregarded the existence of those sarcomata arising in bone and characterized by extensive bone production in the primary growth with similar bone production in metastases no matter in what tissues these develop.

Many malignant tumors bear considerable resemblance to the normal structures in which they arise. For example, a carcinoma arising from a bile duct reproduces roughly, atypical bile ducts in the primary growth and metastases, epidermoid carcinomata, reproduce atypical skin, etc. Likewise, in the presence of malignant tumors arising in bone with atypical bone production in the primary growth and in the metastases, no other explanation is possible but that there is a malignant degeneration of a bone forming cell, an osteoblast,—a malignant degeneration in which the bone forming properties are retained just as the keratohyaline forming properties are retained in certain squamous cell carcinomata of the skin (pearl formation) or collagen forming properties are retained in sarcomata arising from ordinary fibroblasts.

The following are two instances of such bone sarcomata from the collection of Dr. Phemister, and have already been briefly cited by him in the literature:

CASE 1. M. G., aged 18 years. The primary tumor was in the upper portion of the tibia forming a spherical mass protruding posteriorly. Figure 1 is a roentgenogram of a gross longitudinal section of the specimen showing irregular bone formation throughout the growth (mottled shadows). There is new bone formation within the tibia as well as out in the

Fig. 1. Case 1. Roentgenogram of gross longitudinal section of upper portion of tibia showing irregular distribution of newly formed bone in tumor both within and outside the shaft.

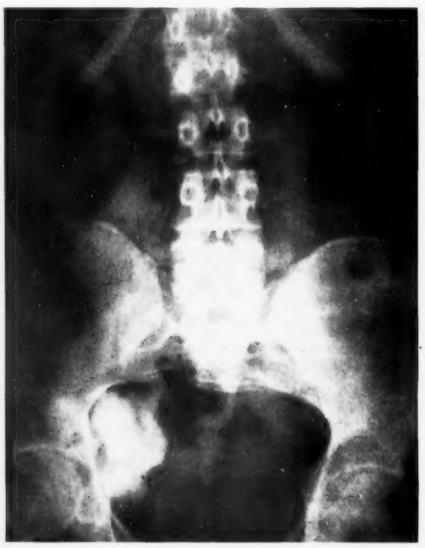

Fig. 2. Case 1. Roentgenogram of pelvis and lumbar spine showing dense shadows in the inguinal lymph nodes which are due to bone producing metastases from a tumor of the tibia.

xtracortical portion of the tumor. Practically no estruction of the tibia is seen. Figures 2 and 3 are oentgenograms showing dense shadows of ossified netastases in the inguinal lymph nodes and lungs, espectively.

Microscopic examination of sections from the rimary tumor and metastases reveals a neoplasm omposed of rounded and polyhedral cells with oderate amount of cytoplasm and oval nuclei con- aining finely stippled chromatin. There is every- here an inherent tendency to bone formation. In arge areas there are anastomosing osseous bands be- ween which there are collections of tumor cells. In places these bands widen into trabeculæ of mature one (Fig. 4).

CASE 2. T. V. I., aged 38 years. Bone Sarcoma Registry No. 335. The primary tumor involved the upper portion of the humerus where it presented an oval swelling. Figure 5, a roentgenogram of the amputated specimen, shows new bone throughout the tumor in the form of spicules radiating at a 45 degree angle from the surface of the shaft. In the upper mesial portion is a large oval area of tumor devoid of bone, this zone being composed of cartilage. Figure 6, a roentgenogram of the chest taken some time before death, shows extensive metastases casting a dense shadow (bone).

Subsequent to amputation, other metastases developed in the skin of the face and scalp and in the left pectoral muscles. Figure 7 is a roentgenogram of a skin metastasis in the facial region, showing ossification. At autopsy one lung was found to be surrounded by a heavy shell of bone (pleural metastases) and extensive bony metastases were present in the other.

Histological examination of that part of the primary tumor outside the shaft of the humerus shows it to consist of irregular anastomosing trabeculæ of bone, the spaces between which being filled by large rounded or spindle-shaped tumor cells with one or sometimes several nuclei. In areas in which bony trabeculæ are being formed, tumor cells are seen to be included to form the bone cells. In some fields irregular masses of neo-formed cartilage are present. The neoplasm is, nevertheless, essentially an osteogenic sarcoma. Sections from the pulmonary metastases afford identical pictures to those seen in the primary growth (Fig. 8). Bone is likewise present in a section from the skin metastasis (Fig. 9). Another metastasis in the muscles of the left side of the neck is composed of spindle cells arranged in a whorl about a central cartilaginous area.

A case of osteogenic sarcoma in a mouse with an ossifying metastasis is recorded from the colony of Miss Maude Slye. Sections of a large tumor of the femur show it to be composed of narrow irregular anastomosing bands of tumor osteoid tissue surrounding areas of anastomosing bony trabeculæ (Fig. 10). In the spaces between these trabeculæ are closely packed, small, rounded and polyhedral cells with hyperchromatic nuclei and little cytoplasm. A metastatic nodule in the liver is also composed essentially of osteoid tissue and bony trabeculæ with tumor cells packed in the spaces between the trabeculæ (Fig. 11).

Fig. 3. Case 1. Roentgenogram of chest showing dense shadows cast by bone producing metastases in lungs from osteogenic sarcoma in tibia.

Grieg, in a recently published monograph on "Surgical Pathology of Bone," states: "A metastasis from a sarcoma reproduces its original cells more or less accurately but it never produces bone unless its vascularity

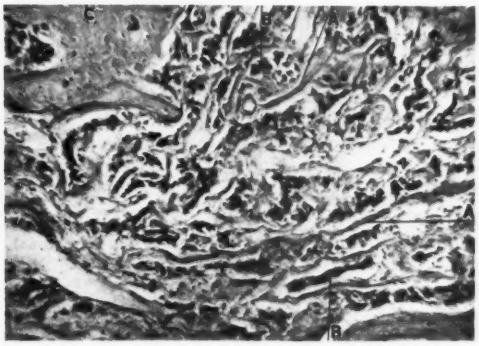

Fig. 4. Case 1. Photomicrograph of primary osteogenic sarcoma in tibia showing *A*, osseous bands between nests of tumor cells *B*. *C*, An island of mature bone.

Fig. 5. Case 2. Roentgenogram of specimen showing osteogenic sarcoma, primary in upper half of humerus. Bone in the tumor is seen as spicules radiating at 45 degree angle from surface of cortex. Note rarefaction in neck and large area, *A*, containing almost no bone (cartilage).

taps some supply of calcium whether it be a physiological reservoir such as bone or a more heterotopic collection of calcium previously accumulated. If the cells of a sarcoma were bone forming, the metastases would certainly be osseous in all. This they certainly are not. It is significant that a professional pathologist even of wide experience with whom I have discussed the matter, can not recall from his own experience a single case in which even one metastasis from a periosteal or endosteal osteogenic sarcoma contained bone. The fallacy of the frequency of its occurrence seems to be promoted from textbook to textbook on the strength of some wellnigh unique specimen preserved on account of its rarity. When, on rare occasions, a metastasis shows apart from bone, a bony structure, it is significant that that metastasis is situated in a site where calcification is known commonly to occur."

This author is quoted in detail since, believing in the correctness of the humoral conception of bone formation, he attempts an explanation for bone producing metastases of bone sarcoma, at the same time inferring that such sarcomata do not exist. However, his views are not consistent with evidence at hand. In the first place, cases of osteogenic sarcoma with bone production in the metastases are by no means "well nigh unique." In addition to the animal and human cases described, a review of the literature reveals additional cases. LeCount, in 1909, collected a number of instances of osteogenic sarcomata with bone producing metastases; these are included in the series in Table I.

It is not possible to obtain a definite conception of the incidence of ossifying metastases from osteogenic sarcoma, due to the fact that in the great majority of cases on record there is incomplete data concerning the roentgenographic and histological appearance of the metastases. It is unusual to find a detailed autopsy report from a case of osteogenic sarcoma that exhibited extensive bone formation in the primary growth.

Osteoblastic properties on the part of the tumor cells themselves may be strongly suggested by extensive atypical osteoid tissue and bone formation throughout the primary neoplasm. But final proof of such properties lies in their ability to produce bone in any tissue they may develop, that is in the ability of the neoplasm to produce ossifying metastases.

In those osteogenic sarcomata producing ossifying metastases, the presence of cartilage is not an uncommon finding, and may well be interpreted as an irregular variation of neoplastic bone forming cells. Malignant degeneration of chondroblasts, on the other hand, gives rise to chondrosarcoma, tumors that constitute a separate class, having characteristic roentgenographic and histological structure as recently pointed out by Phemister. Limited calcification and bone formation are noted in these neoplasms, both in the primary growth and in the metastases. This ossification is an expression of maturation of certain portions of the neoplasm, since in

Fig. 6. Case 2. Roentgenogram of chest after interthoraco-humoral amputation of left arm, showing dense shadows of bone producing metastases in lungs and pleura.

the general economy of the body, the greater part of all cartilage formed during development is finally substituted by bone.

The conception that the extensive bone formation present in the mestastases of the tumors described above is due to the tapping of a "physiological reservoir" of calcium as stated by Grieg is untenable. In the first place, what little calcium and bone may be present in healed tuberculous processes of the lungs cannot possibly be sufficient to furnish enough calcium salts for the extensive bone formation present in the pulmonary metastases of some of these tumors. Furthermore, in those cases in which bone is produced in metastases in the liver, inguinal lymph

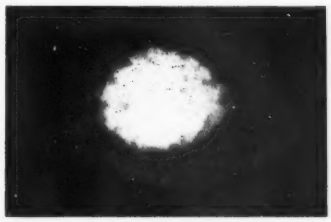

Fig. 7. Case 2. Roentgenogram of excised cutaneous bone forming metastasis in skin of face from osteogenic sarcoma of humerus.

nodes, skin, and pericardium, it would be far fetched to suppose that there existed calcareous deposits in these locations prior to the development of metastases so that the extensive ossification present in them is due to the "reworking" of this calcium into bone by the malignant metastatic cells. Again, were bone formation in osteogenic sarcoma simply due to malignant mesoblastic cells growing in close proximity to a supply of calcium, it should be an easy matter to produce experimentally, osteogenic sarcoma by causing a transplantable fibrosarcoma (embryonic type) to grow about a deposit of calcium in the tissues.

Experiments of this type have been performed and will be discussed in a subsequent paper. Suffice to state here that sarcomata containing bone, similar to the ossifying metastases in the cases described, were not produced.

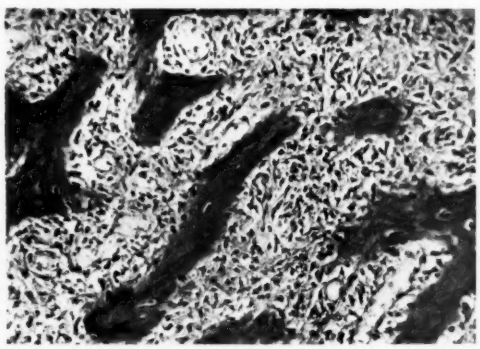

Fig. 8. Case 2. Photomicrograph of metastatic pulmonary nodule showing bone of tumor cell origin, some of which are included within the bone to form bone cells. ×110.

Fig. 9. Case 2. Photomicrograph of cutaneous metastasis showing the formation of bone about hair follicle. ×110.

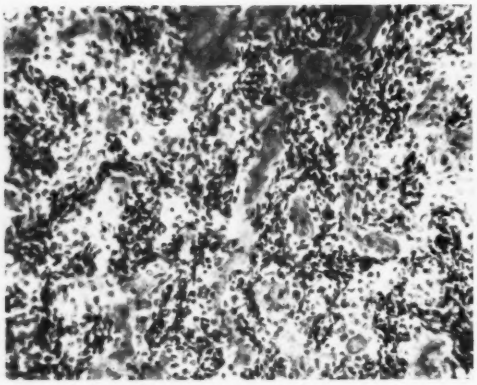

Fig. 10. Osteogenic sarcoma of femur in white mouse showing anastomosing trabeculæ of tumor osteoid tissue and bone, separated by small tumor cells.

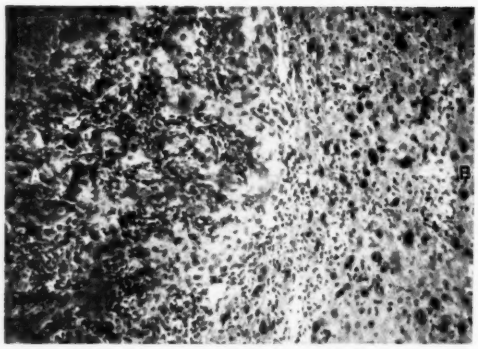

Fig. 11. Photomicrograph of periphery of metastatic osteogenic nodule in liver of white mouse. *A*, Tumor exhibiting osteoid tissue and bone. *B*, Liver. ×110.

To repeat, the evidence afforded by the existence of the type of bone sarcoma here again described, in which there is much bone formation in the primary growth with similar extensive ossification in the metastases, no matter in which tissues they develop, is practically conclusive for the existence of the osteoblast or bone forming cell, since these neoplasms represent malignant degenerations of these cells. No other explanation can account for them.

In pointing out this evidence for the existence of the osteoblast, the authors do not wish to deny that there are reasons for believing that a local or general increase in calcium may be sufficient to stimulate osteogenesis. After all, the osteoblast is a specialized form of the fibroblast, and there is ample evidence to indicate that almost any fibroblast may be stimulated to form bone. For, as stated by Nicholson, "Bone has been found in and around areas of necrosis and calcification in nearly every organ and cubic inch of the body. It is always produced by the cells of the areolar tissue that have proliferated to form a barrier of granulation tissue around the calcified 'foreign body.'" It is quite possible that calcium when present in sufficient quantity for sufficient length of time, and in the necessary chemical combinations is capable of bringing forth osteogenic properties in mesoblastic cells, properties that under normal conditions are dormant.

So much has already been written concerning the terminology to be used in osteosarcoma that any further comment in this direction is done only with the greatest hesitation. The term "malignant osteoblastoma" has been applied to the tumors mentioned above because it expresses the true nature of the neoplasm. In the past these tumors have been included under the general heading of osteogenic sarcoma. On the other hand, they constitute such a distinct group in the large general class of sarcomata arising in bone that they are entitled to a special consideration. Yet, this term "malignant osteoblastoma" is not a new one. It has been used in the German literature (4, 13) to designate a rather rare type of neoplasm arising in connection with bone, and composed of large rounded cells lining short trabeculæ of newly formed bone, or simply forming soft tissue masses. These cells appeared very much like the cells regarded as osteoblasts seen in normal osteogenesis, hence the use of the term "osteoblastoma." Such a designation, however, appears to be unjustified since the very few original reports contain insufficient evidence of osteoblastic activities on the part of the tumor cells, and the histological nature of metastases from these tumors is not described.

In closing, it may be stated that a sarcoma in growing from the bone in which it arises may elevate the periosteum ahead of it causing this membrane to form new non-tumo

TABLE I

Author	Date	Site of original tumor	Location of bone forming metastases
Ballie	1793	"Around the knee"	Lungs
Hillier	1855	Femur	Lungs, both subpleurally and deep, omentum, and diaphragm
Wilks	1857	Lower third of femur	Mass involving sternum and mediastinal glands
		Femur	Lungs
		Lower third of femur	Lungs and mediastinal lymph glands
		Femur	Lungs
		Arm (humerus ?)	Lungs
Virchow (36)	1858	Femur	Lungs
Virchow (37)	1864	Upper third of humerus	Lungs
		Femur	Inguinal and pelvic lymph glands, lungs, and pleuræ
Stimson	1877	Lower third of femur	Lungs, pleuræ, pericardium, dura mater
Allin	1878	Upper third of humerus	Pleuræ, lungs, iliac, and paravertebral glands
Oberst	1880	Lower third of femur	Lungs
Durham	1883	Upper third of femur	Calvarium, temporal bone, opposite tibia, iliac glands, lungs and heart
West	1883	Left knee region	Lungs and pericardium
Pitts	1886	Radius	Epitrochlear and axillary glands, lungs
Power	1889	Tibia	Lungs, pleuræ, clavicle, and ribs
Hektoen	1893	Upper third of tibia	Heart and lungs
Borst	1902	Femur	Lungs
Jenckel	1902	Lower femur	Lungs, pleuræ, and pericardium, inguinal glands, neck glands, tonsil
		Lower femur	Lungs and pericardium
Feistmantel	1904	Middle third of femur	Destructive metastases to sacrum and lumbodorsal vertebræ Ossifying metastases to lungs
Ribbert	1914	Not stated	Lungs
Mills	1924	Pelvis	Lungs
Kolodny	1927	Not stated	Lungs
		Not stated	Skin
Clark	1928	Femur	Lungs
Geschickter and Copeland	1930	Lower third of tibia	Lungs
Geschickter	1932	Not stated	Lungs
Jaffe	1933	"Extremities" (3 cases)	Lungs and pleura
Bone Sarcoma Registry, American College of Surgeons			
Case 764		Lower femur	Roentgenological evidence only of ossifying pulmonary metastases
Case 857		Upper Femur	Roentgenological evidence only of ossifying pulmonary metastases
Case 942		Lower femur	Roentgenological evidence only of ossifying pulmonary metastases
Case 939		Upper tibia	Roentgenological evidence only of ossifying pulmonary metastases
Case 914		Lower femur	Histological preparations show ossifying pulmonary metastases

bone. This constitutes another factor in new bone formation in osteogenic sarcoma. Such new bone is obviously not due to the osteogenic activity of the neoplastic cells, and were this the only source of new bone in an osteogenic sarcoma, the metastases would not ossify. This phase of the problem will be discussed in a subsequent report of our "Studies in Bone Sarcoma."

CONCLUSIONS

1. Two cases, and one instance in an animal, of bone sarcoma are reported and 37 collected from the literature in which there was ossification of both the primary tumor and of the metastases in various tissues.

2. No explanation can account for these tumors but that they are malignant degenerations of osteoblasts or bone forming cells.

Thus they afford conclusive evidence for the existence of osteoblasts.

3. The term "malignant osteoblastoma" is suggested for this group of ossifying bone sarcomata, which should be considered a distinct subdivision of the general group of sarcomata arising in bone. Further study may reveal that all true osteogenic sarcomata are malignant osteoblastomata.

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THE GINGIVÆ DURING PREGNANCY

An Experimental Study and a Histopathological Interpretation[1]

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THE following study, reported here in a preliminary way, and begun about a year ago, was prompted by the frequency of gingival changes observed in pregnant women. The source of our clinical material for observation was Sloane Hospital, whose patients are routinely referred to "Dentistry" for mouth examination and treatment, and the School of Dental and Oral Surgery, Columbia University.

"Pregnancy gingivitis" may assume four forms. These may or may not be progressive stages of the same underlying factors.

The first form is characterized by bleeding of the gums when traumatized by toothbrush, food, etc. If there has been a pre-existing tendency toward bleeding, this tendency is often exaggerated during pregnancy.

In the next form, usually, only the free gum margin is involved; it takes on the color and appearance of a raspberry. The highly inflamed tissue bleeds easily on being probed. While it may appear in any part of the mouth, it is more commonly found in the region of the anterior teeth. This form of "pregnancy gingivitis" is designated "raspberry red gums."

The third form is a generalized hypertrophy of the tissue. Here, the gums are swollen, assume an old rose color, and if irritation is present, the borders become a bright red. The gum papillæ become hypertrophic or grow out from the under surface of the free gum margin to cover a large portion of the tooth, pushing the normal gum back and forming a straight, blanched line immediately above the proliferative tissue. This type of gingivitis is usually confined to one section of the mouth although it may involve more than one area. Irritants, such as food impactions, calculus, soft deposits, and lack of function on one side, are often found on or under the free gum margin. Sometimes no irritants are apparent. The gums bleed easily on being probed, but are seldom, if ever, painful. This form is called "hypertrophic gingivitis of pregnancy."

Fourth, is the so called "pregnancy tumor," which is usually confined to a single growth, springing up at any point in the mouth. At the beginning, it appears to be an overgrown gum papilla. It may be sessile or pedunculated. After it has attained considerable growth, it resembles an epulis varying in size from about 1 to 2 centimeters in diameter, sometimes larger. In color, it is for the most part cyanotic, but bright red on the border. Many times it interferes with mastication and the trauma to which it is subjected produces an area of grayish necrosis on parts of the surface. It may begin early in pregnancy, usually grows rapidly and bleeds easily.

Here also, gingival irritants may be present. The growth starts during pregnancy and for this reason is known as "pregnancy tumor." It differs from the ordinary epulis in that it may either disappear entirely, or diminish greatly in size after parturition.

All forms of "pregnancy gingivitis," if not properly treated, are likely to recur with subsequent pregnancies. Moreover, "pregnancy gingivitis" may or may not be accompanied by a subacute or chronic Vincent's infection, suppurative periodontoclasia, or the presence of fungi and bacteria in the tissue.

Since the patients are seen for the most part after the first or second month of pregnancy, we cannot determine exactly the onset of the gingivitis. The only accurate datum that we

[1] A preliminary report presented in abstract form at a meeting of the Faculty of the School of Dental and Oral Surgery, March 15, 1933.

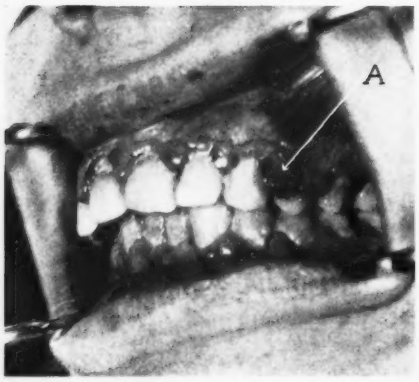

Fig. 1. An enlarged photograph of the gingivæ of Mrs. J. B. (Case 5 of Table I). Note the hypertrophic papillæ covering in part each tooth, which are old rose in color. The largest of these, *A*, has grown to the size of a so called pregnancy tumor and has the characteristic bright red border (seen as black in this print).

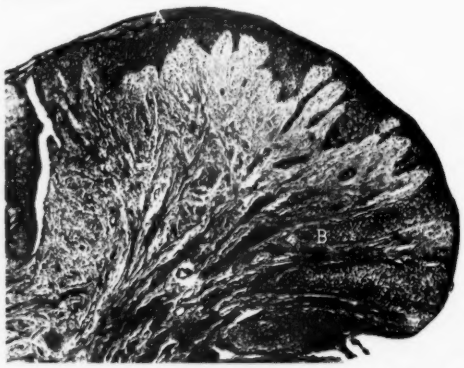

Fig. 2. A low power of one of the papillæ of Mrs. J. B. (shown in Figure 1). Here the corneous layer, *A*, is present, and the epithelial pegs, *B*, show a marked tendency toward downgrowth, but are blunt and do not split frequently.

can obtain is the time when bleeding of the gums was first noticed.

Figure 1 is a photograph of the gingivæ of Mrs. J. B. during the fifth month of pregnancy and is illustrative of some of the changes described above.

This affection is not limited to pregnant women. It occurs also in non-pregnant women, in men, very frequently in boys and girls at the time of puberty, and in women during the menstrual period. A hypertrophic gingivitis in a non-pregnant woman may easily be carried over into pregnancy. Hence, we are not justified in unqualifiedly diagnosing all such conditions as springing solely from the pregnant state.

But it is clearly to be seen—and may we emphasize this point—that the great majority of these gingival changes occur at times usually associated with hormone change—during pregnancy, menstruation, and puberty. This observation led us to experimentation with laboratory animals by the injection of various hormones in an attempt to determine whether or not such hormones play an etiological rôle.

Our study may be divided into two parts, clinical and experimental.

1. Clinical. We made routine examination of the mouths of 416 pregnant women, and recorded the presence or absence of "pregnancy gingivitis." We noted the type of affection present, the size and extent of the involvement of the gingivæ, and the presence or absence of sources of irritation. In some mouths where not all the papillæ were involved macroscopically, we also studied the grossly uninvolved papillæ, obtaining biopsies of both classes. Microscopical findings of these will be reported later.

Further observation included mouth hygiene, tendency to easy bleeding of the gums on being traumatized, and spontaneous bleeding. Then we attempted to ascertain whether hæmorrhage due to traumatization occurred only after pregnancy, or if it was already present before pregnancy, was it increased with the onset of the term.

Each patient was given a toothbrush for actual demonstration of the method usually used in brushing her teeth. We tried to learn if use of a new toothbrush could have caused the increased bleeding, or if some change in the manner of brushing might be responsible.

Of the 416 pregnant women examined, 158, or 37.9 per cent, had some form of observable "pregnancy gingivitis." Of the latter number, 111, or 70.2 per cent, had the hypertrophic type; 65, or 41.1 per cent, showed raspberry red gums; and 3, or 1.8 per cent, pregnancy tumor. Included in this classification are 21 cases, or 13.2 per cent, which disclosed combinations of the foregoing forms.

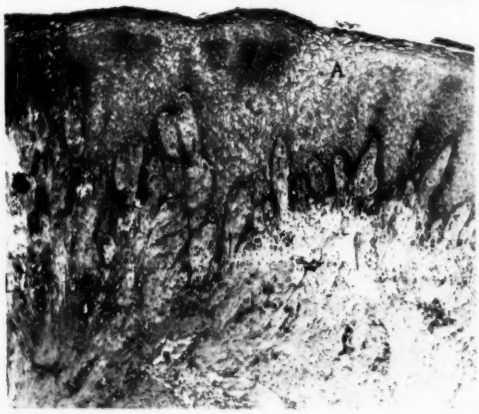

Fig. 3. A low power of one of the grossly involved papillæ of Mrs. E. B. (Case 22 in Table I). Here, the corneous layer is almost entirely absent, the stratum granulosum is deep and the epithelial pegs are pointed and split frequently. Hydropic change, *A*, is seen throughout the entire epithelium.

Fig. 4. A low power of a papilla normal on gross inspection (Mrs. E. B., Case 22 in Table I). Note similarity to Figure 3. The corneous layer here, as in Figure 3, is almost entirely absent, while the stratum granulosum is deep. The epithelial pegs are deep and pointed and split frequently. Hydropic change is not as marked as in Figure 3.

Location of "pregnancy gingivitis" was as follows: anterior area, 114; bicuspid area, 98; molar area, 80; molar and bicuspid areas combined, 16; bicuspid and anterior areas combined, 12; molar and anterior areas combined, 6; molar, anterior, and bicuspid areas combined, 50; incomplete histories, 3.

Hæmorrhage on traumatization was evident in 295, or 70.9 per cent, of the entire group. Among these, 7, or 0.2 per cent, also had spontaneous hæmorrhage. In 171 cases, or 57.9 per cent, hæmorrhage was noted before pregnancy, with the tendency, in most instances, toward accentuation during the term. In 115 cases, or 38.9 per cent, hæmorrhage started after the onset of pregnancy. Of these 115 patients, 62 presented "pregnancy gingivitis" while of the 62, irritants in relation to "pregnancy gingivitis" were apparent in 53. In 9, or 0.3 per cent, histories were incomplete.

Histories as to the use of a new toothbrush being associated with the onset of hæmorrhage were essentially negative. In all, there were 44 patients who acquired new toothbrushes within a few months of the time of examination. Of these, 6 patients related the acquirement of new brushes to the onset of hæmorrhage.

Irritation was found to be present in relation to "pregnancy gingivitis" in 119 cases, or 75.3 per cent, of the 158 mouths thus affected. In 39, or 24.7 per cent, there were no demonstrable irritants in relation to the affected gingivæ. Some form of irritation, with or without relation to "pregnancy gingivitis," existed in 400, 96.1 per cent, cases. Sixteen, 3.9 per cent, mouths were free from irritants.

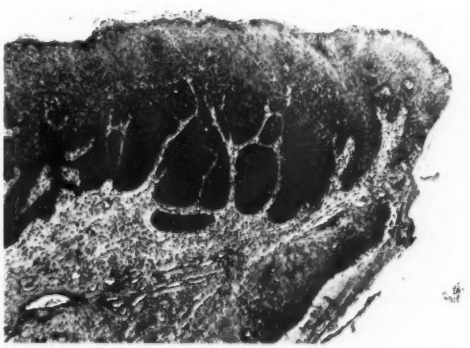

Fig. 5. A low power of one of the involved papillæ of monkey No. 123. The epithelium is hyperplastic, with some tendency to downgrowth of the pegs.

TABLE I.—HISTOLOGICAL STUDY OF PREGNANCY GINGIVITIS

	Case No.	Name	Gross appearance of lesion: Type: Hypertrophic	Gross appearance of lesion: Type: Raspberry red	Gross appearance of lesion: Type: Pregnancy tumor	Gross appearance of lesion: Size	Gross appearance of lesion: Location	Stratum corneum: Width	Stratum corneum: Hydropic change	Stratum granulosum: Width	Stratum granulosum: Hydropic change	Stratum germinativum: Elongation	Stratum germinativum: Splitting	Stratum germinativum: Pearls	Mitosis	Ulceration	Submucosa: Inflammatory cells	Submucosa: Dilation of vessels	Submucosa: Hemorrhage	Bacteria and fungi
4th month	1	A. H.	P	O	O	+	Ant.	++	±	±	+	+	−	o	◘	o	+	?	?	◘
	2	G. D.	O	P	O	±	Rt.	++	+	±	−	+	−	o	o	+	++	+	o	+
5th month	3	V. H.	P	P	O	+	Ant.	+	+	+	+	+	−	+	+	+	++	+	±	±
	4	A. K.	P	O	O	+	Gen.	++	±	±	−	+	−	o	o	++	++	+	±	+
	5	J. B.	P	O	P	++	Gen.	++	±	±	+	++	±	o	o	?	+	±	o	+
6th month	6	E. B.	P	O	O	+	Gen.	±	−	+	±	+	±	++	o	o	±	±	o	o
	7	W. I.	P	O	O	±	Ant.	+	−	±	±	+	+	±	o	o	+	+	o	±
	8	H. L.	P	O	O	+	Gen.	±	−	+	+	±	±	±	o	o	++	+	o	+
	9	A. G.	O	O	P	+	Ant.	+	−	++	+	+	±	o	o	+	++	±	+	o
7th month	10	E. Y.	No	rmal	appea	ring	Post.	−	◘	+	+	++	−	o	o	+	++	±	o	?
	10	E. Y.	P	O	O	±	Post.	−	o	+	+	++	−	o	o	+	++	?	?	±
	11	M. H.	P	O	O	±	Ant.	−	o	±	±	++	−	o	o	+	++	+	−	−
	12	Y. G.	O	O	P	++	Ant.	−	◘	++	±	+	+	±	◘	++	++	+	◘	+
	13	M. B.	P	O	O	±	Gen.	±	−	++	+	+	+	o	?	?	++	?	?	+
8th month	14	H. G.	No	rmal	appea	ring	Ant.	+	−	+	+	+	+	o	o	?	++	?	o	++
	14	H. G.	P	O	O	±	Ant.	+	−	+	+	+	+	±	o	?	++	±	o	o
	15	S. K.	P	O	O	±	Gen.	−	o	++	+	+	−	±	±	+	++	+	o	+
	16	C. M.	P	P	P	±	Gen.	−	o	+	+	+	−	o	o	±	+++	+	o	+
	17	E. N.	P	O	O	+	Gen.	−	o	+	+	+	±	±	o	?	+++	o	o	+
	18	P. G.	P	O	O	+	Gen.	±	−	+	+	++	±	o	o	+	+++	+	+	o
	19	W. P.	P	O	O			−	o	++	+	++	+	o	o	+	++	+	o	+
9th month	20	M. C. M.	P	P	O	+	Gen.	−	o	+	++	++	+	o	o	+	++	+	o	+
	21 (18)	P. G.	P	O	O	+	Gen.	−	o	++	++	++	++	o	++	o	±	+	o	o
	22 (6)	E. B.	No	rmal	appea	ring	Post.	−	o	+	++	++	++	o	o	o	±	o	o	o
	22 (6)	E. B.	P	O	O	+	Gen.	−	◘	++	++	++	++	o	+	+	±	o	o	o

P—Present. O—Absent. Order of degree of change −, ±, +, ++.

Three hundred and twenty-two, 77.4 per cent, women showed unhygienic mouths; 23, 5.5 per cent, clean mouths, of which 17 possessed irritants without relation to "pregnancy gingivitis," and of the 17, 6 had "pregnancy gingivitis."

Sixty-seven, 16.1 per cent, had filthy mouths. History was incomplete in 4 instances, 0.9 per cent. None of the women brushed her teeth correctly, although most of them claimed to use a toothbrush.

Marginal gingivitis was found to be present in the region of the buccal surface of the upper second molars and the lingual surface of the lower second molars in 284, 68.2 per cent, of all the patients, while in 39, 9.3 per cent, other marginal gingivæ in the molar regions were inflamed. Ninety-nine, 23.7 per cent, showed marginal inflammation in the bicuspid regions. Marginal inflammation in the region of the anterior teeth was disclosed in 130, 31.2 per cent, cases.

Microscopical sections made from the biopsies were studied with the following objects in view: (1) to determine whether or not a relationship existed between the month of pregnancy and microscopical findings; (2) to determine whether or not a relationship ex-

isted between the form of the disease and microscopical findings; (3) to determine whether or not a relationship existed between extent of involvement and microscopical findings.

Accordingly, changes in the stratum corneum, stratum granulosum, and stratum germinativum of the epithelium were recorded, as well as changes in the submucosa. The details are shown in Table I.

It will be seen from Table I that with advance in pregnancy there is a gradual and definite decrease in the thickness of the *stratum corneum*. During the early months, a slight increase in thickness is noticeable, but in the last months this layer disappears almost entirely. Some hydropic change of the corneum occurs early in the term.

The stratum granulosum is here shown to be generally hyperplastic, varying from a lesser change during the early stages to a more marked hyperplasia in the last months. However, the changes in this stratum did not take place in as orderly a fashion as in the corneous layer. Hydropic change in the stratum granulosum was confined in the early months mostly to the superficial parts, whereas in the last months the entire stratum was involved.

A definite tendency toward elongation of the epithelial pegs was found in the stratum germinativum. In the later months, not only was this condition exaggerated, but the pegs split more frequently and were generally pointed, whereas earlier, they had been blunt. Epithelial pearls appeared more often during the first half of pregnancy. Mitosis, occurring both early and late in pregnancy, was seen in only a few of the sections.

Figure 2 is a photomicrograph of a section of gum tissue taken during the fifth month of pregnancy, while Figures 3 and 4 are photomicrographs of different papillæ taken from the same mouth during the ninth month. Figure 3 is of a gum papilla grossly affected with hypertrophic gingivitis, while in Figure 4 the papilla appeared normal, grossly.

In studying epithelial changes from the standpoint of the type, size, and extent of involved papillæ, we were unable to record any relation between gross and microscopical findings. Thus, papillæ, grossly uninvolved (see Fig. 4) were microscopically similar to involved papillæ (see Fig. 3). Likewise, the degree or kind of involvement did not materially alter the order of change described as taking place early or late in pregnancy.

Inflammatory changes, in varying degrees, resembling those commonly apparent in granulomata of the gums, were prevalent in the submucosa in all cases. Pregnancy tumors and raspberry red gums evidenced the most intense changes. Ulcerations and hæmorrhage were present in some instances, while bacteria and fungi were seen in about two-thirds of the cases.

2. *Experimental.* The next phase of the study was carried on with rats. Gums of eighteen adult female rats were examined and found to be normal, pink in color, and firm in texture. Twelve of the females were paired with twelve males, while the remaining six females were segregated as controls. When the rats became pregnant, they were again carefully studied. Some were examined for macroscopic changes of the gums during two or three successive pregnancies. Finally, in order to make a comparative study of the effect of pregnancy and irritation on the gums, a string ligature was tied around one tooth so placed that it came in contact with the gums.

Thirty young adult female rats, whose gums were found to be normal, were ovariectomized. The animals were then placed in four separate cages. Group I comprised eight rats about whose upper incisor a string had been tied. They received subcutaneous injections of the following agents: theelin, antuitrin S, and pregnancy urine (untreated). The eight rats in Group II received similar treatment, except that no artificial irritation of the gums was induced.

After studying one hormone, injections were discontinued for several days before a new agent was tested. All injections were subcutaneous. The vaginal smear test of Allen and Doisy was used to determine the effect of these hormones on the estrus cycle.

Cage III contained seven rats and served as control for Cage I, and all the rats had ligatures tied about a tooth to induce irritation. Cage IV was the control for Cage II.

TABLE II.—GINGIVAL CHANGES IN THE IMMATURE MACACUS MONKEY AFTER INJECTION OF PREGNANCY URINE EXTRACT

Number	Route of administration	Time	Days	Papillæ								Calculus	Débris	
				Œdema	Marked enlargement	Proliferation	Old rose	Anæmia	Non-traumatic hæmorrhage	Marginal gingivitis	Interproximal gingivitis			
108 M.	Subcutaneous	B.I.	36	−	−	−	−	−	−	±		−	−	Pregnancy urine extract 14 days preceding this examination and then castrated
		1st A.I.	30	+	−	−	−	−	−	+		−	−	Incisal edges and cusps chalky
		Peak												
		After peak	37–44					++						
109 F.	Subcutaneous	B.I.												
		1st A.I.	12	−	−	−	−	−	−	−		−	−	
		Peak	18–20	+	−	−	−	−	−	+		−		
		After peak	25	−	−	−	−	++	−		+	−	+	2-3| Papilla shortened and inflamed
112 F.	Subcutaneous	B.I.												
		1st A.I.	12	−	−	−	−	−	−	+		−	−	
		Peak	15	+	+	−	+	−	−	+		±	+	
		After peak	18–20	+	−	−	−	++	−		+	−	+	Papilla |1-2 swollen but very pale
114 F.	Subcutaneous	B.I.												
		1st A.I.	7	±	−	−	±	−	−	±		−	−	
		Peak	10–13	+	+	+	+	−	−		+	−	−	Injected blood vessel |iv
		After peak	15–20	±	−	−	−	−	−	±	−	−	++	1-1 |1-2 Papilla cyanotic
115 F.	Subcutaneous	B.I.												
		1st A.I.	4	−	−	−	−	−	−	−		+	+	
		Peak	28–42	+	+	−	+	+(32d day)	+	+		−	−	
		After peak	82	±	−	−	+	−	+					
116 M.	Subcutaneous	B.I.	1	−	−	−	−	−	−		±		+	
		1st A.I.	3	−	−	−	−	−	−	±		−	±	
		Peak		−	−	−	−	−	−	±		−	−	No changes seen except anæmia
		After peak	14	−	−	−	−	++	−	−		−	−	
118 F.	Subcutaneous and intravenous	B.I.	3	±	−	−	−	−	−	±	±	−	−	4 days after anterior pituitary extract started
		1st A.I.	2	+	−	−	−	−	−	+	±	−	−	
		Peak	10–13	+	−	−	+	−	+	++	+	−	+	
		After peak	20	+	−	−	±	±	+	±	−	−	+	16 days after injection started both ovaries removed
119 F.	Subcutaneous	B.I.	5–1	−	−	−	−	−	−	−	−	+	±	
		1st A.I.	4–8	−	−	−	−	−	−	−	−	+	±	
		Peak	19–33	+	+	+	+	±	+	+	+	−	−	Pseudo papilla. Distended vessel |3-iv in areolar and alveolar gingivæ
		After peak	37–43	±	−	−	−	−	−	+	+	−	−	

B.I.—Before injection.
1st A.I.—First examination after injection.
2-3| Gum papilla between upper right lateral incisor and cuspid teeth.
|1-2 Upper left central and lateral incisor teeth.
|iv Upper left first temporary molar.
1-1 |1-2 Gum papilla between upper central incisor teeth and upper left central and lateral incisor teeth.
|3-iv Upper left cuspid and first temporary molar.

Throughout the entire experiment, we observed the gums for macroscopic changes. At varying intervals, we took biopsies of the gums of the rats in each of the cages.

Thus far, our findings in the rat are for the most part inconclusive. We noted no gross changes in the gums. On the other hand, microscopical examination showed some epithelial changes bearing a resemblance to the changes in the vagina of the rat reported by others studying the sex hormones. However, these changes are so slight, that we are unable, at this time, to draw conclusions.

The next series of experiments was on the young immature Macacus rhesus monkey. We were fortunate enough to learn that Dr. Earl T. Engle was using these animals for a study of the effects of the various sex hormones on the organs of reproduction. With his kind permission, we were able to observe the gums of the monkeys during the course of his experiments.

Of the eight monkeys studied, six were females, of which one was ovariectomized. Of the two males, one was castrated. All eight animals were injected with an extract of pregnancy urine. The urine, before being injected, was precipitated with alcohol, ether extracted and concentrated, according to a modification of Zondek's method.

Biopsies were obtained on two monkeys before injections were begun; on six, after the animals were killed; two died, making biopsy unattainable.

Details of this phase of the work are listed in Table II.

It will be noted that we examined the mouths of four of the monkeys before starting pregnancy urine injections, finding three essentially negative. The fourth monkey, No. 118, had been receiving anterior pituitary extract for 4 days before we saw her, and some of the anterior gum papillæ were slightly œdematous before the pregnancy urine extract was given. All the six females observed showed definite gross changes of the gums as the injections continued. The papillæ became œdematous and enlarged in all, but were especially evident in four. In five, these enlarged papillæ subsequently took on the old rose color characteristic of human "pregnancy gingivitis." Proliferative changes of the gums occurred in two monkeys. Non-traumatic hæmorrhage was observed in three of the animals. Marginal gingivitis, probably arising from retained food and débris, was present in all eight animals.

Changes in the gums reached the highest point in their development generally between 10 to 20 days after the daily injections of pregnancy urine extract were begun. After reaching the peak, the changes receded. The enlarged papillæ gradually grew smaller and the color fainter, the gums assuming a decidedly anæmic appearance in most of the animals.

Microscopical study of the foregoing changes in the monkey are at this writing incomplete. Such microscopical slides as we have studied show slight hyperplastic changes of the epithelium and some inflammatory cells in the submucosa. In one monkey, No. 123, whose reaction was not manifest in time for inclusion in the above chart, there was definite hyperplasia of the epithelium *without* inflammatory changes in the submucosa. This monkey showed gross changes similar to those already enumerated. The biopsy was taken approximately 3 weeks after the peak of the changes was noted. A photomicrograph of a section is shown in Figure 5.

DISCUSSION BY DR. STOUT

My connection with this investigation by Drs. Ziskin and Blackberg has been an attempt to evaluate the histological changes in the gums of the rats, monkeys, and pregnant women and I shall confine my remarks to that phase of the work. The study was hampered by the facts that (1) there is great variation in gum epithelium in different individuals, in various papillæ in the same individual, and in different parts of each papillæ; (2) that the majority of the papillæ show evidences of inflammation and this is usually associated with epithelial hyperplasia; (3) that the microscopic changes are relatively slight; and (4) the individual case could not be controlled because it was impossible to remove a papilla for study and still have it left for further changes to occur. Therefore, it was necessary to compare different individuals or different

papillæ from the same individual, which is valuable only if the changes observed are marked and relatively constant.

In the gums of the pregnant women, it seems to me that Drs. Ziskin and Blackberg are justified when they say that the stratum corneum becomes progressively thinner as pregnancy advances from the fourth to the ninth month and that the strata mucosa and germinativa become thicker and more œdematous, and the epithelial pegs extend deeper into the submucosa. These changes occur on the anterior part of the papilla toward its apex. Variations occur due no doubt to the degree of inflammation and infection which is present in every case but, allowing for this, there seems to be a definite trend in the whole group.

The observations on the monkeys are fewer but they seem to confirm the findings in the pregnant women. That is, those monkeys which were injected with pregnancy urine extract seemed to show some degree of epithelial hyperplasia both with and without inflammatory changes. The finding of this hyperplasia in monkey No. 123 without any accompanying inflammatory reaction seemed very significant. In this monkey we had for comparison another papillæ removed before injection. This showed an inflammatory reaction in the posterior or dental mucosa but without epithelial hyperplasia either anteriorly or posteriorly. If this finding can be confirmed by other similar experiments, I believe that we can regard the question as settled.

EVALUATION AND CONCLUSION

1. While irritants are usually found associated with gingivitis in pregnant women, this affection may develop in the absence of such irritants. Hence, it would seem that irritation is a complicating factor rather than a causative one.

2. Since traumatic hæmorrhage from the gums begins so often after the onset of gestation, it is probably a complication of pregnancy.

3. Because hyperplasia is the most notable change in the epithelium, because it increases with advance in pregnancy, and because it is also commonly present in certain organs of reproduction during this state, it seems probable that pregnancy plays an etiological rôle in the production of epithelial hyperplasia.

4. The inflammatory changes in the submucosa cannot be linked with the month of pregnancy. Consequently, they are probably secondary in character.

5. Gross changes, resembling "pregnancy gingivitis," produced in the monkey by injection of pregnancy urine extract, were found microscopically to be hyperplasia of the epithelium, pointing to the probability that the hormones were the causative agents.

6. One monkey, No. 123, showed hyperplasia of the epithelium, without inflammatory changes in the submucosa. This leads us to believe that epithelial hyperplasia is the primary change.

7. The significant change in the gums in "pregnancy gingivitis" is hyperplasia of the epithelium.

Note.—We acknowledge indebtedness to Drs. Earl T. Engle, Raphael Kurzrok, Isidor Hirschfeld, and C. C. Lieb, for many valuable suggestions, and to Drs. Charles F. Bodecker, and Lester R. Cahn, our thanks are due for permitting us the use of their laboratories.

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THE EFFECT ON THE INFANT OF MORPHINE ADMINISTERED IN LABOR

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THE relief of pain during childbirth has interested scientific workers for generations. The search for new and more effective sedative agents has been carried on for a century. Scarcely a month passes without the introduction of some new drug guaranteed to banish its age old pains without doing harm to the mother and her newborn baby. The fact that the obstetrical attendant has so many new and old drugs at his disposal—all exploited to do the impossible—speaks for their relative ineffectiveness. Likewise, such drugs are not as innocuous for both mother and child as their manufacturers would have us believe. The ideal analgesic in labor has not yet been discovered. The majority of us still find that morphine or its derivatives, alone or combined with some other agent, is the most useful and the least dangerous. At the Chicago Lying-in Hospital we have tried many of the various new agents introduced, but we have invariably returned to morphine. Many other institutions and practitioners have had the same experience. What is there in morphine narcosis during labor that prevents it from being the ideal analgesic? Undoubtedly it is the effect that the drug has occasionally on the newborn baby. This so called "narcotization" of the newly born has given obstetricians many anxious moments. Difficulty with the baby after a normal pregnancy and successful labor is not a welcome experience. It has occurred to us that a careful study of the effect of narcosis on the newly born, including the evaluation of all the factors that enter into the picture, would be a timely contribution. We have always had the opinion that the frequency of occurrence of asphyxia due to morphine was overemphasized, and its prognosis made unduly grave. Moreover, no detailed observations on this subject have appeared in the literature since the early days of "twilight sleep"—25 years ago.

CLINICAL OBSERVATIONS

Our study consists of observations on 320 infants, including three sets of twins, born at the Chicago Lying-in Hospital during the year 1932. The mothers of these infants received varying doses of morphine sulphate alone or in combination with other drugs for the relief of pain during labor. In some instances, the large dosages used and the time intervals at which they were administered were designed primarily for this study. The cases, for the most part, were unselected, but the series includes a disproportionately large number of cæsarean sections because they were better suited for this problem. In them we could control more accurately the time interval between the administration of the drug and the birth of the baby, as well as rule out many complicating traumatic factors involved in delivery *via* the natural passages. Throughout this paper "morphine" refers to morphine sulphate unless otherwise noted, and all figures which are mentioned are in terms of morphine sulphate.

Early in this study it became apparent that the picture which we know as "narcosis of the newly born" may be influenced by a variety of factors. There is, likewise, an extraordinary variability in the manner in which different babies will react to identical conditions. The most important of these factors are the size of the dose, the interval between its exhibition and the time of delivery, the extent of the trauma of delivery, the condition of the child *in utero*, maternal toxæmia, anæsthesia, and adjuvant sedatives used. All of these factors were studied separately wherever possible, and also collectively in order to evaluate the true pharmacological action of morphine on the baby when administered to the mother in labor. It is interesting to note that a large number of infants born under optimum conditions for the production of narcosis showed no trace of the effects of the drug.

The size of the dose of morphine seems to have relatively little influence on the production of narcosis in the newborn. Its incidence was as great when dosages of 0.0004 and 0.0005 grams were used, as when 0.03 gram was used. In some instances, however, the larger dosages caused marked narcosis in the child.

The time interval between the administration of the drug and the birth of the baby is the most important factor in the occurrence of neonatal narcosis. During the first hour following the exhibition of the drug, few babies show any signs of narcosis, and after 6 hours the same is true. In Figure 1 this is well demonstrated. The incidence of narcosis becomes progressively greater in the second and third hours after its administration, reaching a peak at about 3½ hours. Seventy-seven per cent of the babies narcotized from the use of 0.010 gram of morphine, and 72 per cent after the use of 0.015 gram, fall within this 5 hour period. It is even more noteworthy that 25 of our 26 cases of really deep narcosis fall within this time interval. As the curves demonstrate, from 10 to 15 per cent of all babies showed symptoms of "narcosis" without regard to the time elapsing after such use. The rôle played by the drug in the production of such "asphyxia" is impossible to evaluate. If the child is pallid rather than livid, with large pupils which remain large, when it reacts poorly to external physical stimuli and to gas resuscitation, one may be sure that other factors play the major part. The trauma of labor especially is a significant and confusing factor here. A good example is a case in which we gave pituitrin following the birth of the first baby of a pair of undiagnosed twins. The mother had had morphia during labor. The first child was normal in every way. The second and better developed baby came with a rush following a single hard pain, and was deeply "narcotized."

When other drugs are used with morphine to increase or prolong its sedative action their combined effects are variable, depending on the adjuvant drug. Scopolamine, when combined with morphine, tends toward a cumulative effect, thereby increasing the incidence of narcosis in the newly born. This was denied vigorously by Gauss, who thought that scopolamine was harmless to the newly born. He thought that morphine was the offender in the combination which he used first, and by reducing its amount he decreased the incidence of narcosis. Hocheisen cited one instance of infant "oligopnœa," due, however, to scopolamine alone. Van Hoosen claimed that morphine was responsible for the entire narcotic effect on the infant produced by morphine and scopolamine combinations. In our experience the complementing of morphia with sodium luminal or magnesium sulphate did not increase the incidence of neonatal narcosis.

The gestational age of the baby and its weight do not appear to be important factors in the occurrence of narcosis in the newly born. In Table I there are a number of cases cited in which very small previable babies began spontaneous respirations immediately after birth without any evidence of narcosis, although their mothers had received large doses of morphine in labor. As a large majority of our babies were at term and of normal weight, it is difficult to decide conclusively as to the influence of the weight of the child on the incidence of narcosis. However, of the 320 babies in our series, 28 weighed 2,000 grams or less. In this small group, 15 babies were delivered without complicating factors, such as trauma, maternal toxæmia, or intrauterine asphyxia. It is most interesting to note that none of the 15 showed any symptoms of morphia narcosis at birth. The average dose of morphine used in this group was as large or larger than that used in the entire group of cases. Indeed, in some of these patients unusually large and frequent doses of morphine had been used in an attempt to postpone a threatening premature labor. The mortality figures are also very suggestive. There were 40 babies weighing 2,500 grams or less at birth, and of these, 12, or 30 per cent, died. The mortality of the 27 babies weighing from 1,500 to 2,500 grams was 6, or 22 per cent. These figures compare favorably with the corresponding figure for the period from October 1, 1932, to April 1, 1933, at the Chicago Lying-in Hospital. We had 1,618 infants, of whom 127 weighed 2,500 grams or

TABLE I

Pathological Findings in all Babies Who Died in the Entire Series of Cases

Number	Child	Weight	Lived	Previable	Premature	Intracranial hæmorrhage	Dural lacerations	Atelectasis	Miscellaneous
60109	O	480	2 mins.	+	+			+	
60109	O	475	2 mins.	+	+			+	
64895	B	1,020	30 mins.	+	+	+		+	
49194	H	2,375	5 hours		+	+		+	Early bronchopneumonia
55790	Y	4,150	57 mins.					+	Marked secondary anæmia of mother
54739	S	2,670	4 hours		+			+	Large thymus; petechiæ of lungs and heart
66581	S	795	5½ hours	+	+		+	+	
57574	T	1,665	1 hr. 40 mins.		+			+	Petechiæ of lungs
49852	G	2,350	20 mins. (?)		+			+	
53324	W	1,450	7 hours	+	+			+	
59140	B	3,090	4 days			+		+	Abruptio placentæ. Child had 71 per cent hæmoglobin
55402	S	3,450	4 days			No autopsy			Hæmorrhagic purpura
60403	A	2,795			+	No autopsy			
67859	G	1,720			+	No autopsy			
69578	R	2,040	Several hours		+			+	
66105	R	760		+	+				Incomplete rotation of gut and descent of testis
72176	K	450	9 mins.	+	+			+	
38891	B	? (4½ mos.)	30 mins.	+	+			+	
38866	C	2,025	75 mins.		+	No autopsy			
71887	C	1,900	5 hours		+	No autopsy			Placenta prævia
51520	Mc	4,495	9 days						Meningitis from laceration of scalp produced in delivery

less. Thirty-eight of the 127 died, making a mortality of 30 per cent—exactly the same as the above.

Maternal toxæmia always has been regarded as a contributory factor in the causation of asphyxia neonatorum. Many babies born of toxæmic mothers show definite signs of intoxication. A considerably higher proportion of these babies are lost during and immediately after delivery, as a result of the usual trauma of labor. In a recent unpublished paper, Adair cites significant statistics from the Chicago Lying-in Hospital, covering approximately the last 1½ years. In that time there were 262 cases of non-convulsive toxæmia with 264 babies, and 17 convulsive cases with 17 babies. In the 264 babies delivered of the non-convulsive patients there were 10 previable, 23 premature, and 11 deaths at term. This represents a fetal mortality of 16.7 per cent. Of the 44 who died, autopsy examinations were made in 15, and 6, or 40 per cent, showed intracranial hæmorrhages or gross dural lacerations. The fetal mortality of the hospital from July 1, 1931, to April 1, 1933, was 4.4 per cent for 4,730 births. In the same period of time, postmortem examinations were made in 218 of our babies, and of these 34 per cent showed such intracranial hæmorrhage or laceration.

One might suspect that babies born of toxæmic mothers would be more susceptible

TABLE II.

Pathological Findings in the Dead Babies Born of Mothers with Toxæmia.

Number	Child	Weight	Previable	Premature	Intracranial hæmorrhage	Dural laceration	Atelectasis	Miscellaneous
69578	R	2,040		+			+	
64895	B	1,020	+	+	+		+	
66581	S	795	+			+	+	
55790	Y	4,150					+	Mother had marked secondary anæmia. Lived 57 minutes
59140	B	3,090			+		+	Abruptio placentæ. Lived 4 days. Child had 71 per cent hæmoglobin

to morphine. In our group of mothers exhibiting the usual symptoms and signs of toxæmia, 36 per cent of the babies were born with evidence of narcosis, and 12 per cent had very deep narcosis. On the other hand, the incidence of narcosis in our entire group of babies was only 26 per cent, and only 8.4 per cent showed deep narcosis. Fully 5 of the 21 dead babies in our series had a history of maternal toxæmia. The autopsy findings in these babies are summarized in Table II.

Asphyxia *in utero*, as is indicated by a change in the rate or rhythm of the fetal heart, apparently leads to an increased susceptibility of the infant to morphine. In our series, 22 babies showed signs of asphyxia *in utero*. Of this group, 69 per cent showed symptoms of "narcosis" at birth, while 30 per cent were in deep "narcosis." One must bear in mind the fact that it is often difficult to determine the true cause of asphyxia. However, it is certain that morphine played an important rôle in its causation. In none of our cases did a baby die *in utero*. Veit remarked that he had never seen morphine affect a baby *in utero*. Gauss reported 4 stillbirths in his first 500 cases of "twilight sleep." Siegel reported 2.5 per cent in 200 cases, while Preller reported one intra-uterine death in 200 cases of this sort. Statistics from our own clinic, over a period of 12 years and 11 months, show an average of 2.7 per cent stillbirths in 35,179 deliveries.

That the infant *in utero* can tolerate large doses of morphine over a period of days or even months without showing any unusual effects is a most interesting observation. We have given morphine for days to mothers threatening to go into premature labor, only to have a previable or premature baby born without any signs of narcosis. Mueller, Reiche, and Langstein have reported on the deliveries of addicts. Reiche cites a case in which a pregnant woman took from 0.1 to 0.2 gram of morphine daily. In the last month of pregnancy she had as much as 0.25 gram per day and delivered a normal healthy child. Langstein had 4 addict cases and in only 1 instance was the baby even blue at birth. From these observations one can conclude that morphine does not affect the child *in utero* unless it is born within approximately 6 hours of the last dose. Its effects on the respiratory center, which probably remains entirely quiescent during the intra-uterine existence of the child, is first demonstrable at birth. The effect is definitely not cumulative. This correlates well with our observations on the effect of repeated doses in labor.

Traumatized babies and those who have been subjected to long or difficult labors or operative procedures are more susceptible to morphine narcosis. This is well illustrated in our unusually large group of 64 cæsarean sections. Here nearly all of the babies were delivered ideally, as far as the element of trauma is concerned. Six of these patients received 0.3 gram of morphine at varying time intervals before operation, and the majority of the others had at least one dose of 0.15 gram. These babies had the minimal incidence of narcosis—11 per cent. All but one of the babies with symptoms of narcosis were extracted from the uterus with difficulty.

Of our series, 39 cases had difficult operative deliveries *per vaginam*. Moreover, in the ma-

jority of instances a long labor preceded the delivery. In 23 of the 39 cases there were no other complicating factors, yet in this small group 52 per cent showed "narcosis." The importance of trauma as a predisposing cause is further evidenced by the greater incidence of narcosis in primiparæ, namely, 30 per cent, as compared with 21 per cent in multiparæ.

The effect of the drug on the mother is some indication of its probable effect on her child. Eight of our mothers showed an unusual response to the morphine. Seventy-five per cent of these deeply narcotized mothers had deeply narcotized infants. The size of the mother's pupils is not as useful a guide as the respiratory rate in estimating the depth of maternal narcosis. One of the mothers subjected to cæsarean section had two doses of morphine, 0.15 gram each, which slowed the respirations to 12 per minute during the operation. Her pupils were of pin-point size. The baby was delivered easily but was born deeply narcotized. It did not breathe normally for 18 minutes and its pupils were contracted for hours. It had spells of cyanosis with apnœa for a period of 9 hours, and its tongue was almost black for 20 hours. It made an uneventful recovery.

Inhalation anæsthesia during labor, likewise, predisposes to narcosis in the newly born. We used ether in only 7 cases and can draw no conclusions as to its effect. However, we used ethylene-oxygen in 199 cases. The length of time during which the anæsthetic was administered seemed to be of no significance, but narcosis was about twice as frequent as when local anæsthesia was used. The latter was used in 113 cases (Fig. 2).

Referring to Figure 1, which shows graphically the incidence of narcosis at varying intervals following the administration of morphine, one notes that the most marked correction for the complicating factors discussed above is necessary during the time interval that the morphine has its maximum effect on the child —1 to 6 hours after the exhibition of the drug. This leads to the conclusion that the child is most susceptible to trauma, toxæmia, intrauterine asphyxia, anæsthesia, etc., during the time that it is under the influence of the drug. This susceptibility increases as the maximum

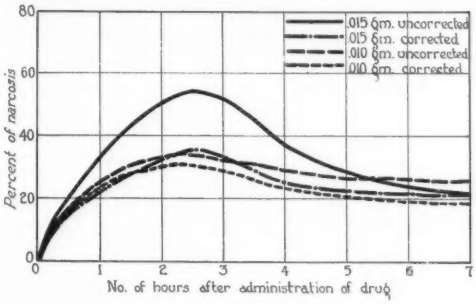

Fig. 1. Incidence of narcosis.

influence of the drug on the child is reached. Clinically, then, morphine should be used most cautiously toward the end of prolonged, complicated labors where the child may be subjected to considerable trauma at delivery. Here the time interval between the use of the drug and the delivery of the child is of utmost importance.

EXPERIMENTAL DATA

As controls for our clinical observations on the effects of morphine we chose 12 newborn infants. These babies had been born by easy, spontaneous deliveries and, in all but one case, of multiparæ. They varied in age from 3 hours to 4 days. They were entirely normal and none of their mothers had had any sedative during labor. These infants were given varying dosages of morphine intramuscularly. Three received 0.0004, two 0.0007, three 0.0009, one 0.001, and two 0.004 gram. They were then observed very carefully over a period of 48 hours. The dose of 0.0004 gram produced little effect. All of the larger doses produced a characteristic picture, which began to develop in 20 minutes and was complete in about 1 hour. Such a baby first became drowsy and increasingly more difficult to awaken. On stimulation it cried briefly and then returned to sleep; often its mouth remained open for some time as if it halted in the midst of its cry. This we soon came to regard as the characteristic "morphine cry." Continued stimulation of such babies often made them apnœic. They became deeply cyanosed and held their breath for as long as 2 minutes at a time. Such apnœa ended with a sudden gasp or two, with the return of bet-

ter respirations and a more normal color. When such babies were put to the breast they were too drowsy to nurse. When the attendants or mothers urged them to nurse they were very much frightened by the appearance of the apnœa and cyanosis described above. On being left alone without handling the babies soon appeared normal, although the respirations might be slowed to as few as 20 per minute, and the heart rate was correspondingly decreased. Their color remained normal and their pupils were of pin-point size. This morphine picture averaged 8 hours in length, although in some instances it lasted as long as 15 hours.

Contrast the above picture with "narcosis" of the child at birth. It may take one or more spontaneous breaths immediately at delivery, only to lapse into apnœa, or apnœa may be present without the preliminary respirations. Cyanosis develops coincident with the apnœa and becomes progressively more marked with the continuation of the latter. The child moves its extremities and wrinkles its face spontaneously or on stimulation. It may grimace or attempt to cry without the utterance of a sound. The reflexes are present and its muscles are quite tonic. The heart beat slows but remains strong and the circulation active. Its pupils are normal in size or dilated and on resuscitation promptly contract to pin-point size. With suitable carbon-dioxide-oxygen mixtures, these babies are resuscitated promptly, and once normal respiration begins, it persists. There is no tendency to relapse into apnœa.

Although the reaction of this experimental group of babies to external stimulation was the same as in the newly-born group, their response to carbon dioxide and oxygen mixtures was much different. As soon as the gas mask was applied the respirations became deeper, their eyes opened, their color improved, and they responded to stimulation with a fairly good cry. As soon as the mask was removed the child at once relapsed into its former sleep. The response to the more concentrated mixtures of carbon dioxide is definitely better than to the less concentrated. The 30 per cent carbon dioxide and 70 per cent oxygen mixture was the most effective.

The literature contains numerous references on the tolerance of very young infants for opiates. Fleischer's case, an infant, 7 weeks old, weighing 5 kilograms, tolerated 0.04 gram of morphine. Ravenna mentioned a 17 month old baby who tolerated 0.010 gram. Wichura reported a 3 month old child weighing 4,600 grams, who tolerated 0.02 gram. Mason had a 56 hour old baby who tolerated 0.008 gram. Porzelt had an 8 month old child who tolerated 0.02 gram, and Sliwinski had a similar experience with a child 1 year old. Kaijser reported a 10 day old child who tolerated 0.01 gram. However, Webster cites the case of a 3 year old child who reacted badly to 2 drops of paregoric, and Kaijser reviewed the literature, emphasizing the danger of opiates for children. Klemm, Lehndorff, Knoepfelmacher, Riether, and Erlendsson have also made interesting contributions on this subject.

The speed with which morphine is transmitted from the mother to the child was studied. Morphine 0.015 gram was administered to different mothers 2, 3, 4, 5, and 6 minutes, respectively, before the child was delivered and the cord was cut. The stools of the infants were examined daily during their stay in the hospital for the presence of morphine. The qualitative tests used were the Marquis, which readily detects 0.0002 gram of pure morphine, and the Wasicky, which detects less than 0.0005 gram. All of these babies first showed positive tests for morphine when bile appeared in the stools on the third or fourth day of life. Some of these infants who died shortly after birth gave strongly positive tests in the tissues of the brain and the liver. The stomach or bowel contents gave negative tests, as Brock had reported previously. These observations support the idea that morphine is eliminated by the liver. Many workers have found that its maximum concentration in the body is in the liver and the brain.

All of the babies whose mothers had received morphine gave positive tests for morphine in their stools, the detection being easiest from the fourth to the seventh day. In our work we attempted to determine the sensitivity of the tests used. We administered smaller and smaller doses of morphine

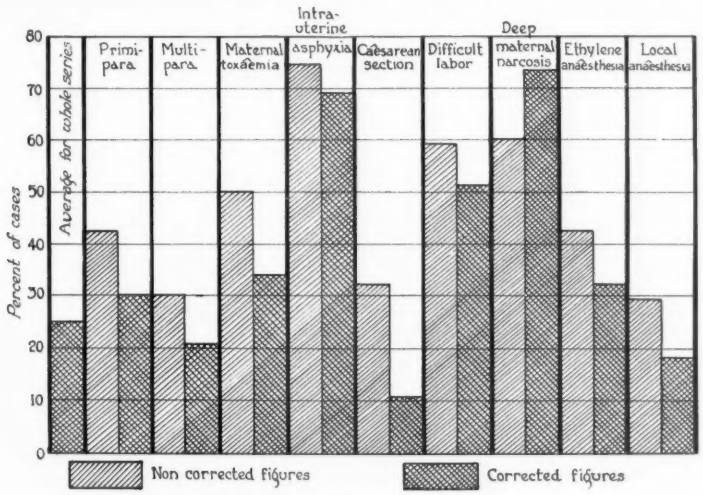

Fig. 2.

intramuscularly to newly born babies, and obtained definitely positive reactions in such stools when the baby received as little as 0.00002 gram. This indicates that these tests are much more sensitive than is the opinion, because only a very small fraction of the minute dose given to the baby could appear in the tiny portion of the stool examined.

Reiche, in working on dogs, demonstrated that morphine given to the mother does not appear in her milk, and cites Walter's corroborative work. Our work shows that morphine appears in the stools of both breast-fed and wholly bottle-fed infants in an identical way, thus substantiating Reiche's experiments. The Wasicky test is differential for morphine and its first oxidation product—pseudomorphine. We have never been able to detect pseudomorphine in the tissues or stools of our babies.

In our work we developed a slight modification of the Wasicky test. In the original test a drop of the specially prepared Wasicky reagent is added to the substance to be tested, and the mixture is then heated, whereupon an intense red color appears. In place of heating the mixture, a small drop of water may be added and this will produce promptly a definite violet or purple color if the substance tested contains morphine. This simplifies the test considerably. However, atropine gives a similar violet reaction, so, of course, this modification can be used only where no atropine has been given.

The fact that morphia passed over from mother to fetus so rapidly suggested that the placenta was a very ineffective barrier. Dr. Adair advised us to analyze some of the placentas quantitatively to determine if morphia given to the mother a few hours before delivery accumulated in the placenta. We added together two placentas, their total weight being 900 grams. The mothers had received a total of 0.061 gram of morphine. The qualitative tests on the pulp were positive, of course. However, quantitative estimations by the Gauss method, which detects 0.000003 gram of pure morphine colorimetrically, and from 0.0001 to 0.0005 gram quantitatively, were negative. This experiment would indicate that the placenta does not retain morphine and is not an important barrier to the passage of morphine to the fetus.

Cloetta, in experiments on animals, found that morphia disappeared from the circulation in 20 minutes. He gave 0.3 gram subcutaneously to a dog and 1 hour later he could find none in the brain. To a second dog he gave 0.4 gram intravenously and the brain revealed no evidence of morphine in 15 minutes, but the liver showed a considerable quantity of it.

Another animal given 0.5 gram showed similar findings. Wachtel gave from 0.4 to 0.8 gram of morphia to dogs and recovered some in the brain, but none in the liver. He noticed that it disappeared almost at once from the blood stream. Lautenschlager gave 0.2 gram intravenously to rabbits. When the animals were killed 3 hours later the brain and stomach contents gave negative reactions for morphine, but the liver, blood, and urine were weakly positive.

We were interested in studying the quantitative amount of morphine actually transmitted to the child by the maternal circulation. We analyzed the brains and medullas of 6 infants who died very soon after delivery. The mothers of these infants all received the accepted sedative dosages of morphine during labor. The medulla and brain were taken together, because Lumsden has discovered the presence of several respiratory centers in the medulla and brain. The tissues were removed as soon as possible after death and analyzed by the same quantitative method of Gauss mentioned. We did not recover morphine in a quantitatively measurable amount in any of the 6 babies, although in 1 case, a baby weighing 450 grams whose mother had been given seven doses of 0.15 gram and one dose of 0.10 gram in the 30 hours preceding delivery, we obtained a definite qualitative reaction. In 2 of these 6 cases an analysis of the liver also proved to be negative for morphine. An interesting observation is that qualitatively the brains and livers of all of these babies gave positive reactions with the Wasicky or Marquis tests. This would indicate the presence of morphia in the tissues in amounts too minute to measure quantitatively.

Two moribund babies whose mothers had not received morphine were injected with the drug after delivery. The first, a previable baby of 1,520 grams, with a large meningocele and a hydrocephalus, received 0.0014 gram intramuscularly 45 minutes before its heart stopped. The second baby, moribund and weighing 1,975 grams, received the same dose 18 minutes before its heart stopped. The brains and livers were analyzed qualitatively and quantitatively immediately after death. The tissues in the first case gave a positive qualitative reaction with the Gauss technique, although the amount of morphia was too small to measure quantitatively. In the second case, a negative qualitative and quantitative reaction was obtained with the Gauss technique. We can, therefore, conclude that babies receive less than 0.0014 gram of morphine through the maternal circulation in the usual case of morphine analgesia. Only where huge doses are given does a comparable amount pass over to the fetus. As mentioned before, such a dose does not produce the signs of "narcosis of the newborn" when administered after birth.

DISCUSSION OF LITERATURE

The literature contains some interesting reports on the effects of morphine on animals. It is well known that the usual experimental animals have various reactions to morphine. In our earlier work we gave huge doses of morphine to pregnant rabbits, totaling as much as 0.23 gram per rabbit, over a period of 2 days. Except for a transient drowsiness and a sluggish reaction to the usual stimuli, they showed no other demonstrable effects. Such animals had litters which were delivered uneventfully and the young appeared entirely normal. There is, likewise, a distinct variation in the reaction of individual animals of the same species. These interesting facts rule out much of the usefulness of the experimental animal in our problem.

Schoen removed various parts of the brains of animals and found that the same dose of morphine could produce opposite effects, depending on the parts removed. Hegar found that a morphinized mouse survived asphyxia twice as long as a normal mouse, and concluded that morphia decreased the organic need for ventilation. Meltzer and Steuber found that cutting the vagi did not modify the effect of morphine on respirations. However, Maloney and Tatum disagree with this finding. Pierce and Plant found that the recovery of morphine from the urine and fæces combined did not exceed 30 per cent of the intake. Light, Torrance, Karr, Fry and Wolff cite investigations of other workers, showing that the muscles take up rapidly large doses of morphia and leave only small

amounts free to reach the central nervous system. The excretion or destruction of morphine must be rapid, for in 8 to 10 days a cured addict may die from the effects of the dose he had usually taken before. They also point out how little of the total intake is recoverable from the urine and fæces.

There is an extensive literature giving the clinical observations on the use of morphine. Much of this dates back to the era of "twilight sleep," when many clinicians first became interested in the technique. No extensive studies have appeared recently, so facts and fallacies together remain in the literature to confuse the student. DeLee states that morphine is relatively safe when given more than 4 hours and less than a half hour before delivery. Aufermann gave morphine intravenously and found that its action was felt at most for 2½ to 3 hours. McIlroy, in a recent paper, revised her earlier opinion on the subject and states that morphine should not be used in primigravida within 3 hours of delivery. There are other interesting discussions on the subject by Brock, Williamson, Spencer, and Thaler. The articles on "twilight sleep" by Susz, Smith, Hochiesen, and von Bardeleben are also very instructive.

SUMMARY AND CONCLUSIONS

In our study on morphine narcosis in the newborn, methods of resuscitation necessarily must be considered. (The old and standard methods are useful in these cases, as in the treatment of "asphyxia" due to other causes.) The air passages should be cleared by means of a tracheal catheter if necessary, and external warmth should be applied. However, external stimulation of any kind is not only of very doubtful value here but it often serves only to deepen the narcosis. Such stimuli may cause the baby to inspire once or twice and then to lapse into apnœa, from which it is difficult to arouse. Thus morphinized babies should be handled gently. A mixture of carbon dioxide and oxygen gases proved to be the most useful stimulus to respiration. Indeed, after our work proceeded for some time, we began to regard the reaction of morphinized babies to these gases as a criterion of true narcosis. We finally concluded that a brief administration of 30 per cent carbon dioxide with 70 per cent oxygen was the ideal mixture, especially effective when followed by pure oxygen. A complete report on this method of resuscitation has been published recently by us.

In Table I there is summarized an account of all of the fetal deaths in our series, together with the pathological findings where autopsies were done. We felt that no baby in this group was lost as a result of morphine narcosis. Indeed, it has been our experience that morphine is a safe drug to use in labor, especially when adequate means of resuscitation are at hand. Many clinicians have relegated this drug to the background because of the possible development of the unpleasant complications of narcosis, only to make use of far more dangerous drugs of doubtful analgesic value.

A few reports on morphia derivatives have appeared recently in the literature. Very slight changes in the structure of the morphine radicle seem to modify markedly the essential pharmacological effects. Alvarez, and Leulier and Pomme have written on dilaudid and oxydimorphine sulphonate, respectively. Can some slight change in the constitution of morphine occur in the body from 1 to 6 hours after its administration sufficient to explain the peculiarities of its effect on the fetus? The effect seen in the newly born cannot be reproduced when various dosages of morphine are injected into infants a few hours old. Yet we have observed that morphine, or a form of morphia so much similar that it answered to the test reactions for morphia hitherto devised, passed over into the fetus within 2 or 3 minutes after it was given to the mother. Infants born before an hour had elapsed or after 6 hours showed little, if any, narcotic effect from the same. During the time when the drug tends to act most strongly on the child, only 50 per cent are affected by it to any noticeable degree. This effect disappears almost immediately with proper methods of resuscitation and for some strange reason does not recur. One cannot reproduce this particular phenomenon with any drug that we know of, in any dose—certainly not with doses of morphine given after birth. Such a

change in the drug cannot be due to its oxidation to pseudomorphine, as the differential Wasicky test did not reveal the presence of pseudomorphine in any of our studies. Balls has shown how difficult it is to detect the brief pseudomorphine stage, and its properties, as he recounts them, are very different from the effects produced on our newly borns. It is of interest to observe that the maternal response to morphia is maximal at about the same time as the newly borns show that the drug is most effective on their respiratory mechanism. Further research may produce a derivative of morphine just as effective for the relief of maternal pain, and less toxic to infants *in utero* as demonstrated immediately at birth.

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EFFECT OF SYMPATHETIC NEURECTOMY ON THE COLLATERAL ARTERIOLE CIRCULATION OF THE EXTREMITIES

EXPERIMENTAL STUDY

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SYMPATHETIC neurectomy of the vasoconstrictor control of an extremity has given encouraging results in selected clinical cases of obstructive arterial disease (1, 19, 30, 34). The increased peripheral circulation following denervation is manifested by a permanent rise in temperature of the limb (7, 12, 20, 33), improved calorimetric (9, 13) and oscillometric (38, 42) findings as well as relief from distressing subjective symptoms due to circulatory deficiency. In the presence of mechanical obstruction in the main artery, this improvement must occur through functionally active collateral vessels. When the collateral channels are involved in the organic obstructive arterial disease there is little possibility of improving the circulation. Pre-operative clinical tests (10, 16, 18, 29, 35, 40, 44) for the functional activity of the collaterals are the basis for selecting cases of peripheral circulatory deficiency suitable for operation. The collateral vessels in these cases are functionally comparable to the normal circulatory channels of experimental animals.

The present investigation is to determine the influence of sympathetic denervation in hastening and augmenting vasodilatation of the collateral arterioles in experimental animals. Actual blood volume flow, direct blood pressure, and superficial and deep temperatures are used to study the peripheral circulatory changes. This report is based upon the results obtained from 260 experiments upon 110 dogs.

PRINCIPLES OF EXPERIMENTS

Ligation of the femoral artery just below Poupart's ligament confined the main peripheral arterial circulation to the collateral channels (Fig. 1). Vasodilatation of the existing collateral arterioles or formation of new anastomoses was determined by changes in the arteriole circulation with and without sympathetic denervation. Distal cannulization of the ligated artery permitted actual blood flow and direct blood pressure observations. The use of the same cannula in the elastic femoral arteries assures the constancy in the size of the outlet in all the experiments. Therefore, dilatation of the existing collateral arterioles would result in an increased blood flow through the cannula accompanied by a corresponding change in blood pressure. On the other hand, the opening of the new collateral arteriole channels may provide an increased circulation with little variation in peripheral blood pressure. Consequently, the results of blood volume flow and direct blood pressure determinations in the following experiments give direct information as to the changes in the collateral arteriole channels. It is possible, therefore, to compare the results with and without sympathetic denervation at corresponding periods after main artery ligation.

TECHNIQUE OF EXPERIMENTS

A large female dog was anæsthetized with morphine sulphate 1 grain supplemented with the inhalation of a minimum amount of ether. Transperitoneal lumbar sympathetic neurectomy was performed from the first lumbar vertebra to the first sacral. Immediately following left lumbar denervation, the left and then the right femoral arteries were isolated through small incisions just below Poupart's ligament. The superficial temperature was obtained by inserting a mercury thermometer subcutaneously between the skin and the internal condyle of the femur. A 2 minute reading was obtained. The thermometer was then placed deeply in the thigh muscles for 2 minutes to obtain the deep temperature. A No. 18 gauge transfusion cannula was introduced into the superficial femoral artery distal to the ligature (Fig. 1). For blood to flow through the cannula necessitated circulation

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through the collateral channels around the ligated main artery. Minute flow calculations were obtained from the amount collected in 15, 20, or 30 seconds to avoid exsanguinating the animal. Direct blood pressures were obtained by means of a mercury manometer. The determinations were made on the left sympathectomized and right unsympathectomized limb for comparison.

The following results were obtained:

Dog 91, operated upon April 18 1932.

Immediately after operation	Left Sympathectomized	Right Unsympathectomized
Temperature—superficial	97°	95.2°
deep	98.2°	96.8°
Blood pressure	70 mm.	60 mm.
Blood volume flow—1 minute	48 c.cm.	27 c.cm.
Blood volume flow—1 minute	54.5 c.cm.	33 c.cm.
Seven months later—November 14, 1932		
Temperature—superficial	93°	97°
deep	98.8°	95.4°
Blood pressure	120 mm.	96 mm.
Blood volume flow—1 minute	123 c.cm.	78 c.cm.
Blood volume flow—1 minute	138 c.cm.	90 c.cm.
Blood volume flow—1 minute	138 c.cm.	90 c.cm.

It will be noticed that the blood flow, blood pressure, and deep temperature readings are constantly higher on the left sympathectomized limb. However, 7 months following sympathectomy, the superficial cutaneous temperature is 4 degrees lower (93 degrees) than the temperature on the unsympathectomized right side (97 degrees).

To eliminate the effects of prolonged anæsthesia and operative manipulations and to evaluate the permanency of the circulatory changes the experiments were grouped in the following series:

1. *Normal findings.* Normal collateral arteriole circulation was studied on the right and left hind limb without sympathetic denervation. Blood volume flow and direct blood pressure determinations were repeated at intervals of weeks and months to obtain the normal physiological improvement in the arterioles following occlusion of the main artery.

2. *Immediate effect of sympathectomy.* Immediate effect of lumbar sympathetic neurectomy was determined from the findings obtained on the two legs before and after unilateral denervation.

3. *Late effects.* Rapidity and permanency of arteriole circulatory improvement was determined at intervals of weeks and months following sympathectomy. These results can then be compared with those obtained at the same time on the opposite unsympathectomized limb as well as the normal obtained in (1).

4. *Cutaneous and deep circulatory changes.* Correlation of the constancy of arteriole circulatory changes following sympathectomy with the capillary skin temperature findings.

Normal collateral arteriole circulation without denervation was determined by distal cannulization of the ligated femoral artery. The constancy of blood flow and blood pressure of the right and left hind legs was verified. The results were almost uniform on the two sides and demonstrated that the effect of sympathectomy may be studied on the one side with the other as control. The following results are representative of those observed in this series:

Dog 62, operated upon February 21, 1932. Femoral artery ligation without sympathectomy.

Immediate unsympathectomized determinations	Left	Right
Blood pressure	38 mm.	38 mm.
Blood volume flow—1 minute	38.5 c.cm.	34 c.cm.
Blood volume flow—1 minute	37 c.cm.	36 c.cm.
Temperature—superficial	97.7°	97.8°
deep	101.4°	101.3°
Nine months' unsympathectomized determinations (November 21, 1932)		
Blood pressure	86 mm.	86 mm.
Blood volume flow—1 minute	138 c.cm.	138 c.cm.
Blood volume flow—1 minute	138 c.cm.	138 c.cm.
Temperature—superficial	94.8°	94.8°
deep	98.6°	98.6°

The immediate effect of sympathectomy was obtained by blood flow and blood pressure findings on the two legs before and after left lumbar sympathectomy. The left sympathectomized limb in some instances had as much as a 100 per cent increase in collateral blood flow while the findings on the right unsympathectomized limb remained unchanged. The fact that the findings on the control limb remained unchanged after opposite side denervation emphasizes unilateral sympathetic vasomotor control. Kuntz (25) believes that a crossed sympathetic control may also exist. The direct blood pressure readings were constantly higher on the sympathectomized side, although to a much less degree than would be expected by the markedly increased blood flow. A 60 per cent average increase in blood volume flow following sympathectomy is associated with a 15 per cent average rise in blood pressure (Fig. 2).

Representative findings of this group are:

Dog 46, operated upon November 10, 1930.

Control determinations before sympathectomy	Left	Right
Blood volume flow—1 minute	24 c.cm.	30 c.cm.
Blood volume flow—1 minute	35 c.cm.	36 c.cm.
Blood volume flow—1 minute	35 c.cm.	36 c.cm.
Temperature—superficial	94°	95°
deep	97.2°	97.4°

Immediately following left lumbar sympathectomy	Sympathectomized	Unsympathectomized
Blood volume flow—1 minute	48 c.cm.	24 c.cm.
Blood volume flow—1 minute	48 c.cm.	31 c.cm.
Blood volume flow—1 minute		30 c.cm.
Temperature—superficial	94.4°	93.0°
deep	99.4°	96.8°
Blood pressure	60 mm.	50 mm.

Late effects. The rapidity and permanency of arteriole circulatory improvement was ascertained by repeating the determinations at intervals of 2 weeks to 10 months after sympathetic denervation. Gradually increasing arteriole circulation on the right unsympathectomized limb demonstrated the physiological response to main artery occlusion. A definitely greater increase was constantly found on the left sympathectomized limb (Fig. 3). Ten months was considered sufficient time for permanency of the changes to take place. At this time the blood pressure distal to the ligature (arteriole pressure) on the left sympathectomized limb equals the normal systemic arterial pressure of 120 to 140 millimeters of mercury. On the unsympathectomized right side the blood pressure constantly remained from 10 to 30 millimeters lower and did not return to the normal systemic level at any time (Fig. 4).

Dog 71, left lumbar sympathectomy performed March 18, 1932.

Immediately after left sympathectomy	Left Sympathectomized	Right Unsympathectomized
Temperature—superficial	97°	95.2°
deep	98.2°	97°
Blood pressure	70 mm.	60 mm.
Blood volume flow—1 minute	48 c.cm.	27 c.cm.
Blood volume flow—1 minute	54 c.cm.	33 c.cm.

Determinations repeated November 14, 1932 (8 months)

Distal femoral artery now pulsating	Left Sympathectomized	Right Unsympathectomized
Temperature—superficial	93.0°	91.0°
deep	98.8°	95.4°
Blood pressure	120 mm.	96 mm.
Blood volume flow—1 minute	126 c.cm.	78 c.cm.
Blood volume flow—1 minute	138 c.cm.	96 c.cm.
Blood volume flow—1 minute	138 c.cm.	96 c.cm.

Cutaneous and deep circulatory changes. Correlation of the collateral arteriole circulatory changes following sympathectomy with the skin capillary temperature findings. Increased circulation through the collateral arterioles constantly followed adequate lumbar sympathetic neurectomy. In these same animals the cutaneous temperature findings as evidence primarily of capillary circulation were inconstant and variable. Frequently elevation of one degree or two degrees in skin temperature after sympathectomy was associated with as much as 50 to 100 per cent increase in actual arteriole circulation. Furthermore, the elevated skin temperature may quickly disappear or even become lower than on the opposite control side.

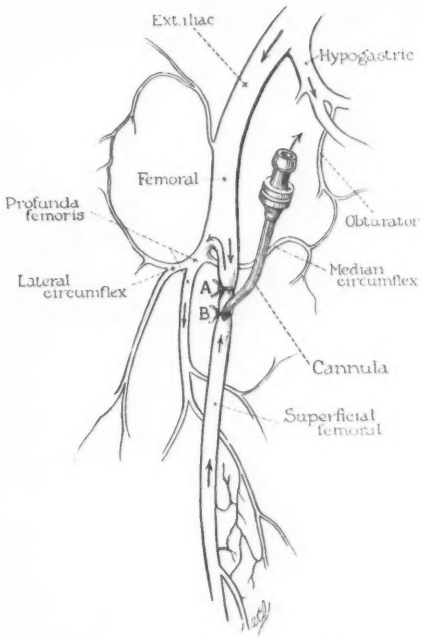

Fig. 1. Method of obtaining actual blood flow and direct blood pressure of the collateral arteriole circulation. The superficial femoral artery is cannulized distal to the ligature. Blood appearing in the cannula must circulate through the collateral vessels around the obstructed main artery.

Dog 90, left lumbar sympathectomy performed September 8, 1932.

Immediately following sympathectomy	Left Sympathectomized	Right Unsympathectomized
Temperature—superficial	96.0°	94.0°
deep		
Two months later, November 11, 1932		
Temperature—superficial	93.0°	94.0°
deep	98.0°	96.4°
Blood volume flow—1 minute	30 c.cm.	21 c.cm.
Blood volume flow—1 minute	34.5 c.cm.	24 c.cm.
Blood volume flow—1 minute	39 c.cm.	27 c.cm.
Blood pressure	80 mm.	66 mm.

RESULTS OF EXPERIMENTS

The collateral arteriole circulation in experimental animals is markedly uniform in the right and left hind legs. A gradual but steady increase in peripheral circulation takes place

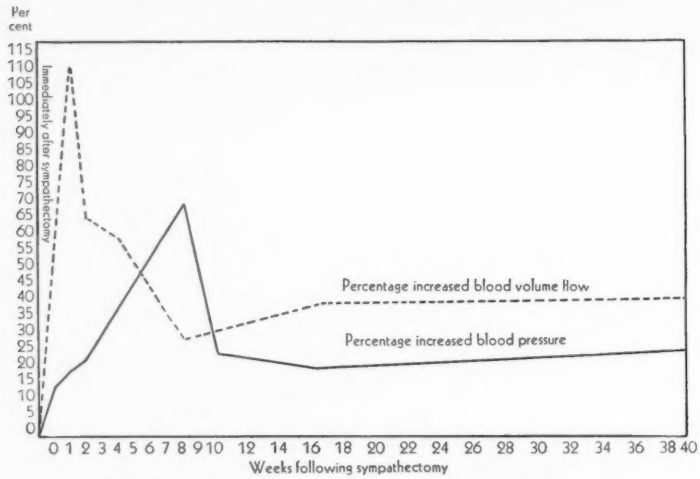

Fig. 2. Percentage increase in average blood volume flow and average blood pressure of the arteriole circulation at week intervals following left lumbar sympathectomy. There is no relationship between increased blood flow and change in blood pressure. The average blood flow is tremendously increased immediately and within the first 2 weeks following sympathectomy. During this time the average blood pressure shows a gradual rise, reaching its maximum 8 weeks after denervation at which time the increase of the average flow on the sympathectomized and unsympathectomized arteriole circulation becomes stabilized.

over a period of weeks and months as a normal physiological response to main artery occlusion. Adequate sympathetic neurectomy of the vasoconstrictor control is followed by an immediate marked increase in collateral circulation. This increase remains constantly greater than the physiological increase taking place in the unsympathectomized leg (Fig. 3).

Blood pressure readings of the arteriole circulation in the right and left legs are as uniform as the blood volume flow. Only slight increase in blood pressure is recorded after sympathectomy but this remains constantly higher than in the unsympathectomized leg. The direct blood pressure in the arterioles eventually (10 months) reaches the systemic level which was present before occluding the main artery. Although the pressure in the unsympathectomized limb steadily increases after occlusion of the main artery, it is constantly lower than the corresponding findings on the sympathectomized side (Fig. 4).

The cutaneous temperature readings are inconstant both on the sympathectomized and unsympathectomized limb. As a rule, the skin temperature immediately following denervation is 1 to 2 degrees higher than on the control limb. This may soon disappear and become even less than on the unsympathectomized limb. Although the skin temperature may be variable, the blood volume flow and blood pressure in the arteriole circulation is markedly uniformly increased following sympathectomy.

DISCUSSION

In animal investigation superficial skin temperature changes have been largely depended upon to confirm and clarify clinical observations as to the effect of sympathetic neurectomy on the peripheral circulation. For the most part the results have not substantiated the clinical enthusiasm for the operative procedure. McCullagh (31) found that recovery of cutaneous vascular control is more complete and more rapidly effected after sympathectomy on laboratory animals than on man. Furthermore, Oughterson and Harvey (36), before the American Surgical Association reported that from 4 to 6 weeks after sympathectomy the skin temperature of the sympathectomized limb was essentially the same as of the unsympathectomized limb.

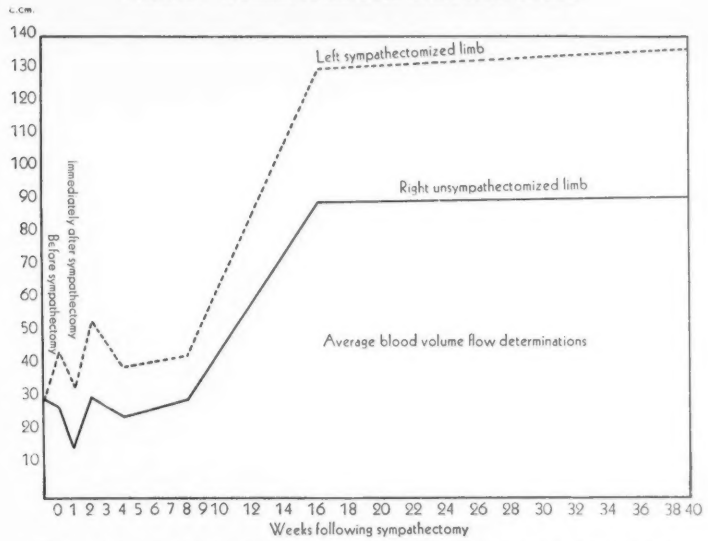

Fig. 3. Average blood volume flow per minute on the right and left legs before, immediately, and at week intervals following left lumbar sympathectomy. The actual blood flow on the left sympathectomized leg was constantly greater than on the right unsympathectomized side.

They explain the variation in results obtained by sympathectomy as due to our lack of knowledge of the exact course pursued by these fibers and particularly the levels at which they leave the spinal cord. However, the inconstant and variable skin temperature findings following sympathectomy on my first series of 50 dogs could not be explained by autopsy findings of inadequate denervation. In analyzing the results of our experiments the conclusion is reached that skin temperature findings alone could not be used as an index of the effect of the sympathectomy on the peripheral circulation on experimental animals.

The body surface temperature is primarily influenced by the peripheral capillary circulation. These capillaries react to both peripheral stimuli and central sympathetic influences (22). Sympathectomy removes the central sympathetic vasoconstrictor control of the capillaries. Sheard (15) studied the peripheral vasomotor capillary reaction following sympathectomy with rapidly changing environmental temperatures. Capillary vasoconstriction was found to be diminished but vasodilatation remained practically the same as in the unsympathectomized limb. These peripheral capillary reflexes, independent of central control, make the use of skin temperature findings unreliable as a basis for studying the effect of sympathectomy upon the peripheral circulation. The presence of small Rouget cells within the capillary wall may be responsible for these peripheral reflexes (24). Jelliffe (23) believes that these ganglion cells are capable of producing reflexes exactly as occurs in all skin and tendon reflexes from terminal stimuli. The fact that skin temperature changes following adequate sympathectomy in experimental animals are inconstant and variable indicates independent peripheral vasomotor reflexes (Kuntz).

Ligation of the main artery of a lower extremity in experimental animals produces a definitely diminished peripheral circulation. Distal to the obstruction the pulse immediately becomes imperceptible and a definite fall in temperature of the limb is recorded. Complete cessation of peripheral circulation is prevented by collateral arteriole anastomoses around the obstructed artery. The adequacy of the initial collateral circulation in dogs was demonstrated by more than 250

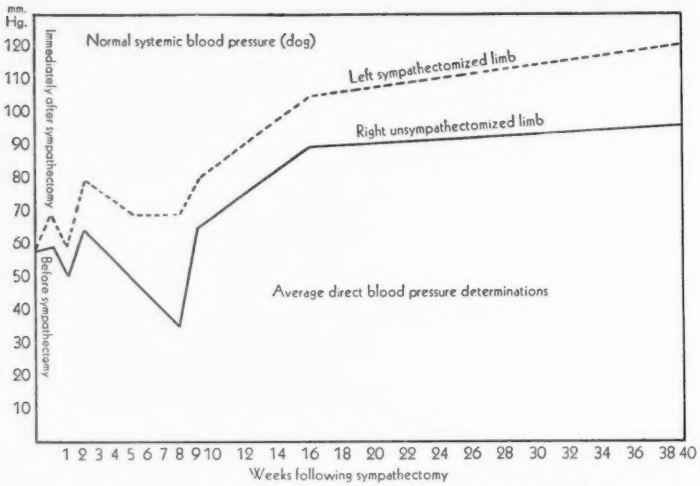

Fig. 4. Average direct blood pressure findings of the arteriole circulation on the left sympathectomized and right unsympathectomized extremities. Before denervation operation the average findings on the right and left sides were constantly uniform (58 mm.). Following sympathectomy the blood pressure on the left sympathectomized limb was constantly higher than on the right unsympathectomized leg. Within 4 to 5 months the pressure of the collateral circulation on the sympathectomized side reached the normal systemic level (120 mm.). The pressure on the right unsympathectomized collateral circulation remained below the systemic level even after 10 months of observation.

femoral artery ligations. Evidence of necrosis or gangrene did not occur in any of the limbs. Gradual improvement in the arteriole circulation follows with a moderate but incomplete return of peripheral pulsation and rise in temperature. The extent of collateral anastomoses is readily demonstrated by roentgenograms (43) of arterial trees in both animal and non-gangrenous human limbs. Where gangrene supervened in human limbs collateral arterioles are either very small or completely absent.

Arteriospasm or hypervasoconstriction of the arterioles in clinical cases exerts a profound influence in increasing the peripheral circulatory deficiency due to main artery obstruction (7, 10, 35, 39). This cannot be duplicated in experimental animals. Consequently, there will be a proportionately less marked subnormal peripheral temperature in animals than is found in humans with main artery occlusion. Relief of arteriospasm by sympathetic neurectomy will in itself provide increased peripheral circulation. However, an actual vasodilatation of the arterioles beyond their normal tone does not necessarily follow from clinical observation.

The effect of lumbar sympathectomy on the circulation of the unobstructed femoral artery on dogs was recently reported by Herrick (21). Using a specially devised instrument, the thermostromuhr, the temperature changes were recorded and used to calculate the blood flow through the vessel. Following sympathectomy, the flow, under local anaesthesia, was almost doubled, indicating a definite dilatation of the unobstructed artery. Increased circulation through the femoral artery following lumbar sympathetic neurectomy demonstrates that the main artery to an extremity is normally under constant vasoconstrictor sympathetic influence.

Arteriole anastomoses are the principal channels of collateral circulation when the main artery to an extremity is obstructed. For clinical application, animal investigation of the effect of sympathectomy should be concerned with vasodilatation of these vessels. By means of a capillary microscope Brown (11) found that skin capillaries following sympa-

thectomy appeared 50 per cent smaller in size but more numerous. The increased skin temperature following denervation is interpreted as due to dilatation of the arterioles. He concludes, indirectly, that sympathectomy "exerts its greatest influence on the arterioles." However, as far as I have been able to find no direct experimental evidence of sympathetic control of arteriole circulation has been reported.

COMMENT

Adequate collateral arteriole circulation in obstructive arterial disease of an extremity is essential in maintaining the vitality of the limb. Various procedures have been recommended to improve the peripheral circulation. Among these, periarterial sympathectomy (4, 14, 26, 27, 32), artery ligation (28) or artery and vein ligation (8, 43), perivertebral sympathetic ganglionectomy, ramisectomy or neurectomy (17), roetgen ray exposure (37) of the vessels of the limb or perivertebral ganglia, physiotherapy (15), hydrotherapy (15) and vaccine therapy (2, 3, 5, 6) have been the most popular. For the most part clinical and animal experimental investigation has failed to confirm the results which were originally reported.

Frequent and numerous clinical reports as to the beneficial effect of sympathetic neurectomy in obstructive arterial disease of the extremities emphasize the importance of properly selecting cases for operation. Adson (30), Filatov (20), and others report improved peripheral circulation following sympathectomy in a series of cases over a five year period. This can be considered permanent.

The results of animal experiments here reported confirm Brown's clinical observation and interpretations. The arteriole circulation is constantly and permanently increased following sympathectomy. If this increase were due entirely to vasodilatation of the arterioles, according to the method of the experiments, the maximum increase in arteriole blood pressure would accompany a maximum increase in blood volume flow. This was not found to be so. In addition to a dilatation of the existing arterioles an increased number of new anastomoses must have opened to form new channels of collateral circulation.

SUMMARY AND CONCLUSIONS

The results of 260 experiments on blood volume flow, direct blood pressure, and temperature findings on 110 dogs are the basis of this report.

Ligation of the femoral artery in dogs did not produce peripheral necrosis or gangrene. Although a definite decrease in peripheral circulation occurred, adequate collateral arteriole circulation maintained the limb's vitality.

Normally, physiological improvement in the arteriole circulation follows main artery occlusion. Gradual but incomplete return of peripheral arterial pulsation and rise in temperature of the limb are evidence of improved collateral arteriole circulation.

Inconstant and variable cutaneous temperature readings on 50 sympathectomized animals could not be explained by autopsy findings of inadequate denervation.

Immediate and permanently increased collateral arteriole circulation follows adequate lumbar sympathectomy on experimental animals in cases of peripheral circulatory deficiency due to main artery occlusion.

Increased cutaneous temperature findings following sympathectomy does not indicate vasodilatation of all the peripheral circulatory channels. Vasodilatation and increased number of collateral arteriole anastomoses accounts for the improved peripheral circulation and indirectly for the increase in skin temperature.

Peripheral cutaneous capillary reflexes independent of sympathetic control are probably responsible for most of the inconstant and variable skin temperature findings.

The results here reported have definite clinical applications. Where functionally active collateral arterioles of the extremities exist, appropriate sympathetic neurectomy produces an immediate and permanently increased peripheral circulation. The procedure should be of great value also in cases of impending peripheral gangrene due to sudden traumatic or operative occlusion of the main artery.

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INTRA-ABDOMINAL PRESSURES CREATED BY VOLUNTARY MUSCULAR EFFORT

II. Relation to Posture in Labor

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In the preceding communication, a method was described for measuring intra-abdominal pressures created by voluntary muscular effort.[1] Thus with an air inflated balloon in the vagina, connected to a mercury manometer, a satisfactory estimate of pressure was obtained.

During the development of the method, it became evident that the pressure which a woman could create depended to a certain degree upon posture. This observation suggested the use of the method as a means for measuring the efficiency of postures commonly employed in labor.

A considerable literature has appeared on posture in labor. From time to time, various postures have been advocated as most efficient on the basis of clinical observations, but no *quantitative measurement* of the relative efficiency of different postures has been described. The present report deals with the measurement of such postural relationships.

MATERIALS AND METHODS

Measurements were made upon 5 healthy women who exhibited no symptoms or signs of pelvic disease at the time that testing was begun. One of them, M.F., had had an appendectomy 16 years, and a right oophorectomy and partial left oophorectomy 11 years previously. None of the others had been subjected to any abdominal operation. Further description of the subjects is given in Table I.

The method of measuring intra-abdominal pressures is described in detail in the first paper of this series. The postures employed in the present study are illustrated in Figure 1.

In order to confine the straining efforts to the use of the abdominal muscles alone, as far as that was possible, pulling with the hands and arms was not permitted.

Two sets of measurements were made on each individual in each posture: (A) the maximum intra-abdominal pressure which could be created on straining, and (B) the weight effect of the viscera upon the vaginal balloon.

RESULTS

A. Maximum pressures created on straining. A total of 1,167 tests, each representing a maximum straining effort, was made upon the 5 women. The results are summarized in Table II. They are arranged according to the averages (weighted) of the intra-abdominal pressures recorded for each posture, the lowest average being found in the lateral prone and the highest in the sitting posture.

It will be seen that beyond a general grouping of *low* averages for postures with the torso horizontal, and *high* averages for those with the torso vertical, nothing significant in the relationships among the postures appears in this table.

The measurements in this table and throughout the paper are expressed in centimeters of mercury (cm. Hg.). It should be remembered that the method employed of estimating intra-abdominal pressures created by straining gives a reading which is too large by 0.7 centimeter of mercury, and that this increase is due to the elasticity of the rubber balloon. No correction has been made for this increase because we are concerned with relative postural efficiency and the same error enters into all measurements.

In order to ascertain how well the pressures created by each individual conformed to the average pressures for the group, the individual average pressures were ranked in order of efficiency from 1 to 7, beginning with the lowest (Table III). From these rankings, an average rank was obtained. By means of the rank order correlation formula, the posture ranking of each subject is compared with the average obtained for all. A grade of 60 per cent

[1] Murphy, D. P., and Mengert, W. F. Intra-abdominal pressures created by voluntary muscular effort: I. Technique of measurement by vaginal balloon. Surg., Gynec. & Obst., 1933, lvii, 487–493.

Fig. 1. Postures employed in studying the effect of posture on maximum intra-abdominal pressures which can be created by voluntary muscular effort.

or more is assumed to indicate fair correlation. Thus it will be seen that despite variations in posture order among the subjects, there is nevertheless a definite trend toward uniformity.

Finally, each posture was compared with every other one. The difference between the weighted averages of any two postures, taken from Table II, was compared with three times its standard error. The result of this comparison of each posture with the remaining ones is recorded graphically in Figure 2. Significant differences between postures are expressed with a plus sign, insignificant differences with a minus sign.

TABLE I.—DESCRIPTION OF SUBJECTS

Identification	Age	Height cm.	Weight kgm.	Abdominal circumference, cm.	Pregnancies No.
M.F.	38	166.0	63.6	76.5	1
A.K.	31	155.6	50.9	66.1	5
M.M.	19	156.0	71.4	73.7	0
R.M.	27	144.8	50.0	65.3	3
A.W.	25	148.0	48.2	71.2	4

B. Weight effect of viscera. A total of 27 sets of readings was made of the effect of the weight of the viscera upon the inflated vaginal balloon when each subject was *not straining*. A set of readings represented one test in each posture and was obtained in the following manner: The balloon was inflated with a pressure of approximately 4.0 centimeters of mercury, the subject standing, and a reading made. The subject then assumed the remaining postures and a reading was made in each without altering the original balloon inflation. The results are shown in Table IV. In order to indicate the *relative* visceral weight effect in each posture, the lowest reading which occurred in knee-elbow in all 5 subjects, was subtracted from each of the seven readings.

TABLE II.—MAXIMUM INTRA-ABDOMINAL PRESSURES CREATED ON STRAINING

Summary of measurements of intra-abdominal pressures created by 5 healthy non-pregnant women when straining their maximums in each of seven postures. Note: (1) order of postures, which is determined by the weighted averages, and (2) that postures with the torso vertical have the higher averages.

Posture	M.F.				A.K.				M.M.				R.M.				A.W.				Total tests	Weighted average cm. Hg.	Standard error of average cm. Hg.
	Tests number	Minimum cm. Hg.	Maximum cm. Hg.	Average cm. Hg.	Tests number	Minimum cm. Hg.	Maximum cm. Hg.	Average cm. Hg.	Tests number	Minimum cm. Hg.	Maximum cm. Hg.	Average cm. Hg.	Tests number	Minimum cm. Hg.	Maximum cm. Hg.	Average cm. Hg.	Tests number	Minimum cm. Hg.	Maximum cm. Hg.	Average cm. Hg.			
Lateral prone	25	*7.2	10.1	8.3	25	*8.2	15.3	11.6	34	11.1	21.8	15.1	25	*7.4	14.2	10.9	15	10.2	13.7	12.3	124	11.8	±0.27
Recumbent	25	9.2	12.0	10.7	130	10.0	17.8	12.4	41	8.8	22.1	14.3	25	9.8	17.8	12.7	25	11.3	17.0	13.9	246	12.7	±0.15
Knee elbow	25	7.8	10.2	9.2	25	10.0	16.4	12.2	20	13.0	21.2	16.8	25	9.8	19.5	14.7	25	12.0	17.6	14.9	120	13.4	±0.29
Semirecumbent	75	9.0	12.8	11.1	25	13.0	20.8	16.3	35	12.2	22.2	16.7	25	9.6	16.8	12.8	25	12.6	18.2	15.1	185	13.6	±0.22
Squatting	25	10.0	13.4	12.1	25	11.3	19.8	14.6	28	10.9	25.2	18.1	25	12.2	16.3	14.5	25	10.0	13.2	11.5	128	14.3	±0.29
Standing	25	11.2	14.4	12.9	46	10.8	20.4	14.3	49	9.8	22.2	15.7	25	13.1	19.1	15.4	25	11.2	14.6	13.5	170	14.5	±0.20
Sitting	25	9.8	12.2	11.2	25	13.2	21.0	17.0	45	12.8	25.3	16.9	25	13.4	17.7	15.9	74	12.0	19.2	15.2	194	15.4	±0.20
Total tests	225				301				252				175				214				1167		

*Basic inflation pressure of balloon 2.0 centimeters of mercury, all others approximately 4.0 centimeters of mercury.

By this treatment of the figures, the visceral weights are given as differences with the lowest ranking posture, knee-elbow, expressed as zero. The effect of visceral weight upon the vaginal balloon was fairly constant from subject to subject—as indicated by the standard errors of the averages for each posture. This was to be expected, since we were dealing with a purely physical phenomenon.

In the knee-elbow posture, the viscera gravitate cranially; this occurs, but in lesser degree, in the lateral prone posture. As the torso becomes more nearly vertical, the weight effect of the viscera becomes greater—being greatest

TABLE III.—MAXIMUM INTRA-ABDOMINAL PRESSURES CREATED ON STRAINING; CORRELATION OF INDIVIDUAL WITH AVERAGE POSTURAL RANK

Postures are ranked in order of efficiency; the lowest being given a value of one. Rankings based on data in Table II. Note that the posture ranking of each patient compares favorably (better than 60 per cent) with the average rank of the group.

Posture	M.F.	A.K.	M.M.	R.M.	A.W.	Average rank
Lateral prone	1	1	2	1	2	1.4
Recumbent	3	3	1	2	4	2.6
Knee-elbow	2	2	5	5	5	3.8
Semirecumbent	4	6	4	3	6	4.6
Squatting	6	5	7	4	1*	4.6
Standing	7	4	3	6	3	4.6
Sitting	5	7	6	7	7	6.4
Correlation with average rank, percent	76	85	76	87	61	

*Best effort not put forth. A mild intercurrent disease was probably responsible.

TABLE IV.—EFFECT OF VISCERAL WEIGHT ON VAGINAL BALLOON

Summary of average differences among pressures exerted upon the vaginal balloon by weight of abdominal viscera, subjects *not* straining. Differences were obtained by subtracting figures recorded for knee-elbow posture (lowest for each subject) from those obtained for all the postures, thus giving knee-elbow a value of zero. Note that the weight of the viscera becomes progressively *more* effective as the torso approaches the vertical.

	Average differences					Weighted averages	Standard errors of averages
	M.F.	A.K.	M.M.	R.M.	A.W.		
Sets of readings	1	11	3	8	4	27	—
Postures	cm.Hg.	cm.Hg.	cm.Hg.	cm.Hg.	cm.Hg.	cm.Hg.	cm.Hg.
Knee-elbow	0.0	0.0	0.0	0.0	0.0	0.0	±0.00
Lateral prone	0.4	0.4	0.8	0.6	0.4	0.5	±0.04
Recumbent	1.3	1.0	1.1	1.3	1.3	1.1	±0.06
Squatting	2.2	1.5	1.9	2.1	2.2	1.8	±0.08
Semirecumbent	1.8	2.3	1.7	2.1	1.8	2.1	±0.07
Standing	2.7	1.9	2.2	2.3	2.7	2.1	±0.07
Sitting	2.8	2.3	2.4	2.7	2.8	2.4	±0.07

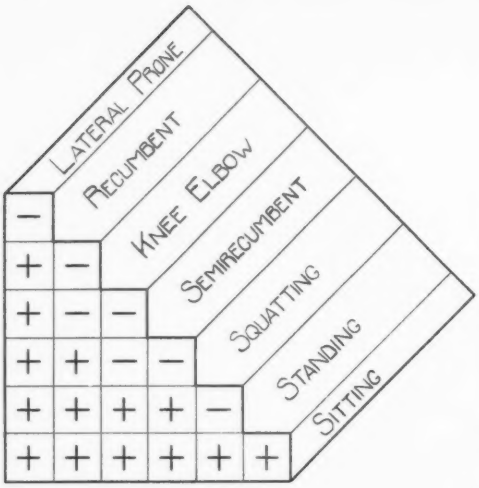

Fig. 2. Correlation of postural differences among the average pressures produced by maximum straining effort. Diagram showing whether or not a significant difference existed between the weighted average pressures of any two postures. The postures are arranged in ascending order of efficiency beginning with the least efficient, lateral prone. Plus represents a *significant*, and minus an *insignificant* difference. For example: knee-elbow (reading to the left) does *not* exhibit a significant difference from recumbent, but *does* show such a difference from lateral prone. Reading down, knee-elbow shows *no* significant differences from semirecumbent and squatting, but *does* exhibit such differences from standing and sitting. From this diagram, it is possible to ascertain whether or not any posture or group of postures is more efficient than any other posture or group of postures.

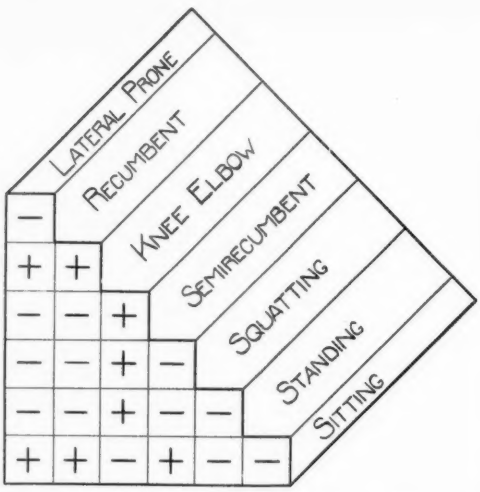

Fig. 3. Correlations of postural differences among the average pressures produced by maximum straining effort *after* subtracting visceral weight effect. Compare with Figure 2. Note that significant differences from other postures occur only in knee-elbow and sitting.

in sitting posture. Here there is not only a maximum effect due to gravity, but also probably some compression of the abdominal viscera by the contents of the thorax.

MAXIMUM PRESSURES CREATED ON STRAINING LESS WEIGHT EFFECT OF VISCERA

The weighted averages of pressures created by straining (taken from Table II) are given in Table V, column 1. The average for lateral prone was subtracted from each of the seven averages in a manner similar to the treatment of the visceral weight averages, thus expressing the weighted averages as differences (column 2). The corresponding visceral weights (taken from Table IV) are recorded in column 3, and the result of subtracting them algebraically from the straining differences (column 2) is shown in column 4.

Two postures, knee-elbow and sitting, show relatively large differences as a result of this subtraction and these differences are significant, being greater than three times their standard errors (column 5). The 5 remaining postures show insignificant differences between the effect due to straining and the effect of visceral weight.

In other words, on the basis of our observations, there are no significant differences in the pressures created by muscular effort in five of the postures which cannot be explained on a simple basis of visceral weight. Knee-elbow and sitting postures, however, have differences too large to explain on that basis alone.

With the visceral weight factor eliminated, the postures are compared with one another in Figure 3 as was done *without* deduction of the visceral weight factor in Figure 2. It will be seen in Figure 3 that there are no significant differences among the postures except in the cases of knee-elbow and sitting.

DISCUSSION

A series of 5 women is admittedly a small one from which to draw conclusions. From Table III, however, we see that the posture

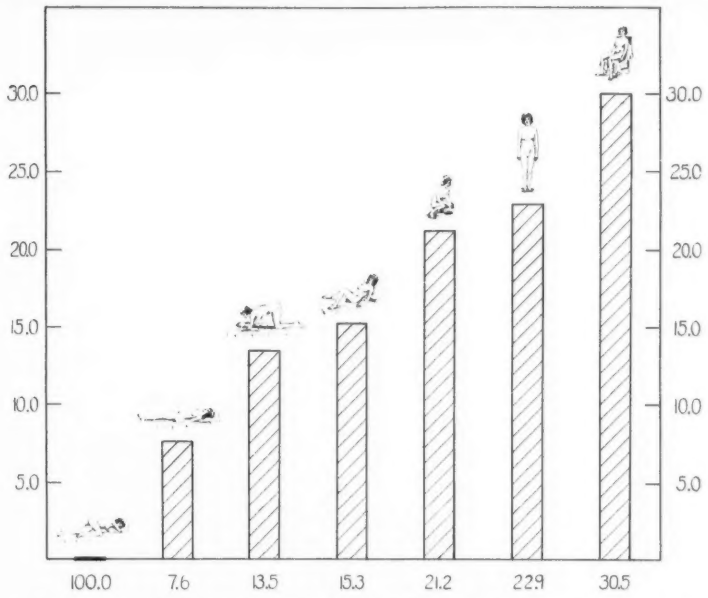

Fig. 4. Postural efficiency in percentages; lateral prone given as 100. Showing the percentage efficiency of the seven postures on the basis that the least efficient (lateral prone) has a value of 100. Note: (1) posture efficiency tends to increase as the body approaches the vertical; (2) posture order does *not* conform to expectation on the basis that visceral weight is the only factor, because knee-elbow and sitting constitute exceptions to this general trend.

order of each of the women has a satisfactory agreement with that of the average order of the group. Also, calculation of the standard errors of the weighted averages (Table II) shows that even the most variable averages (knee-elbow 13.4 centimeters of mercury and squatting 14.3 centimeters of mercury) are not subject to a variation greater than ± 0.29 centimeters of mercury.

None of the 5 subjects was pregnant. Consequently, our observations must be interpreted in the light of this fact, and must not be applied unreservedly to straining ability in the second stage of labor.

The lateral prone posture gives an average reading of 11.8 centimeters of mercury. This represents a pressure of 160.5 grams per square centimeter (2.28 pounds per square inch). The sitting posture gives an average reading of 15.4 centimeters of mercury, which represents 209.5 grams per square centimeter (2.98 pounds per square inch). In other words, a woman sitting in a chair can exert an average intra-abdominal pressure of 49.0 grams per square centimeter (0.70 pounds per square inch) *more* than she can when lying on her side. Figure 4 is a graphic arrangement of postural efficiency and is given in percentage of increased efficiency which each posture has over lateral prone. It may be seen that the difference of 49.0 grams per square centimeter (0.70 pounds per square inch) between the efficiency of sitting and lateral prone postures represents a 30.5 per cent increase in straining efficiency in favor of sitting. To what is this increase due? Is it entirely a matter of visceral weight, or are the abdominal muscles able to contract with greater advantage in certain postures?

Though we had no satisfactory method for measuring *absolute* visceral weight in each posture, we could measure *relative* weight from posture to posture. When this was done, it was found that the order of posture alinement on a visceral weight basis followed theoretical

TABLE V.—MAXIMUM PRESSURES CREATED ON STRAINING LESS WEIGHT EFFECT OF VISCERA

The result of subtracting the visceral weight effect from the straining effect is shown.

Column number	1	2	3	4	5
Description	Weighted averages	Averages column 1 expressed as differences	Visceral weight averages	Straining differences minus visceral weight	3 standard errors of differences of column 4
Postures	From Table II	Lateral prone subtracted from each average	From Table IV	Column 2 minus column 3	
Lateral prone	cm. Hg. 11.8	cm. Hg. 0.0	cm. Hg. 0.5	cm. Hg. −0.5	cm. Hg. 0.82
Recumbent	12.7	0.9	1.1	−0.2	0.49
Knee-elbow	13.4	1.6	0.0	+1.6*	0.87
Semirecumbent	13.6	1.8	2.1	−0.3	1.03
Squatting	14.3	2.5	1.8	+0.7	0.90
Standing	14.5	2.7	2.1	+0.6	0.63
Sitting	15.4	3.6	2.4	+1.2*	0.86

*Note (column 4) that the resulting differences in the cases of knee-elbow and sitting postures stand out from the remaining five, thus demonstrating that these two postures have an efficiency that cannot be explained on the effect of visceral weight alone.

expectation very closely. It will be remembered that the knee-elbow posture was *lowest* in this series, but that it occupied the *third* place in the straining series. In the latter, the pressure difference between lateral prone and sitting was given as 49.0 grams per square centimeter (0.70 pound per square inch) whereas, visceral weight alone was responsible for 27.2 grams per square centimeter (0.39 pound per square inch) of the difference. In other words, the visceral weight effect is responsible for 52.7 per cent, and increased muscular efficiency for 47.3 per cent of the total efficiency increase of sitting over lateral prone.

It will be remembered (Table V) that differences in straining efficiency among five of the postures, lateral prone, recumbent, semirecumbent, squatting, and standing, were due entirely to the gravitational effect of the viscera. Two postures, knee-elbow and sitting, however, exhibited significant differences in straining efficiency which could not be explained on a purely visceral weight basis. In other words, not only does visceral weight play a rôle in differentiating these postures from the others, but also there must be some mechanical advantage of muscular action in the knee-elbow and sitting postures. We will not attempt to offer an explanation of the increased efficiency of muscular action in these postures, being content merely to point out that such a difference in efficiency exists. Both of these postures have been employed extensively in animal and human obstetrics. A posture similar to the knee-elbow—in that the angle of the body with the horizontal, and the angle of the limbs with the body—is used by all quadrupeds in labor, while sitting is the time honored position assumed in the obstetric chair. Undoubtedly, the obstetric chair was abandoned because of the greater readiness with which examinations and obstetrical operations could be carried out with the patient in the recumbent posture. This change probably occurred at about the time of the "obstetrical revolution," when the forceps was introduced into obstetrics.[2] Do the advantages to the obstetrician of having the patient in the recumbent posture outweigh the disadvantages to her? This question cannot be answered dogmatically. Even on the basis of our data we do not advocate, unreservedly, a return to the obstetric chair for delivery. We have shown, however, that five non-pregnant women created 30.5 per cent more intra-abdominal pressure when in the sitting than when in the lateral prone posture, and that this 30.5 per cent increment was composed of two factors: (A) full force of visceral weight. (B) increased efficiency of muscular contraction.

We feel that the results of this quantitative evaluation of postural efficiency suggest a

[2]Mengert, W. F. The origin of the male midwife. Ann. Med. Hist. 1932, n. s. iv, 453–465.

more liberal use of the sitting posture during the second stage whenever it is desired to expedite labor.

SUMMARY AND CONCLUSIONS

The influence of posture upon the maximum intra-abdominal pressure which could be created by straining was studied on 5 healthy, non-pregnant women by means of the vaginal balloon technique previously developed.

Two sets of measurements were made: (B) 1,167 separate observations, each recording *actual* intra-abdominal pressure at the height of a maximum straining effort, were made of the 5 women when in each of seven postures. These were: lateral prone, recumbent, knee-elbow, semirecumbent, squatting, standing, and sitting. (B) Twenty-seven sets of seven readings each were made of the relative effect of visceral weight from posture to posture. In this series of tests, the women were *not* straining. It was found:

1. That the 5 subjects could create pressures averaging 49.0 grams per square centimeter (0.7 pound per square inch) *more* when sitting than when lying in a left lateral prone (Sim's) position. This represents a 30.5 per cent increase in straining efficiency.

2. This increase was made up of two components, (a) weight of viscera, (b) increased advantage of muscular action.

3. Five of the postures, lateral prone, recumbent, semirecumbent, squatting, and standing had only one of these components (visceral weight) and did not seem to possess any increased efficiency of muscular contraction. In other words, any differences among them depended solely on an increase in effective visceral weight as the torso approached the vertical.

4. In two of the postures, knee-elbow and sitting, the subjects were able to use their abdominal muscles to greater advantage. Thus in sitting, visceral weight accounted for 26.8 grams per square centimeter (0.37 pound per square inch) of the 49.0 grams per square centimeter (0.7 pound per square inch) advantage which this posture possessed over lateral prone. This represented slightly more than half of the increased efficiency of this posture. The remainder must have been increased efficiency of muscular action.

5. These observations suggest a more liberal use of the sitting posture during the second stage whenever it is desired to expedite labor.

Acknowledgment is made to Dr. H. C. Bazett, professor of physiology, for his interest and advice during the period of investigation.

The authors are also indebted to assistant professor J. P. Bursk, of the Wharton School of Finance and Commerce, for advice on the statistical calculations necessary to the preparation of our data.

THE ASEPTIC PERITONEAL CAVITY—A MISNOMER[1]

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WE are taught to believe that in normalcy the peritoneal cavity is sterile. Our bacterial studies of the peritoneal fluid led us to believe that this is not true.

In 1928, we began a study of peritonitis. We decided to confine this work to the phenomenon as it occurred in human beings, feeling that only from such a study could we learn anything which would eventually aid the clinician.

The bacteriology of the disease seemed so highly confused that we elected to begin our research problem from this standpoint. At once it was apparent that to obtain data for such a study we had best see what happened when we took cultures from peritoneal cavities which presented none of the clinical manifestations of peritonitis and compare the results of these cultures with those taken from peritoneal cavities which showed recognizable manifestations of intraperitoneal inflammatory reaction.

Much to our surprise cultures obtained from the peritoneal cavities of patients operated upon for such conditions as fibroids, herniæ, "interval appendicitis," and retroversion, under the conditions of operating room technique then in vogue, showed a ready growth of organisms.

Such results were very surprising. Up to that time, we had shared with the bulk of the profession the current belief that cultures from the peritoneal cavity of a normal individual, if opened under aseptic conditions, would show no growth. We at once attributed the positive cultures to contamination due to operative technique.

To ascertain at what point this contamination occurred, we began to take cultures from the skin after preparation and of the knife blades used to make the skin incision.

Although we were using 2 per cent iodine in alcohol and alcohol after cleansing the skin with ether, surface cultures were found to be persistently positive. As a result, the skin antiseptic known as MBGV-5 and reported upon by the senior author in 1928 was evolved. By the use of this method of pre-operative skin preparation, we were sure that our skin surface was sterile. Persistent positive cultures from the skin knife blades were still obtained. They could be explained by one of two theories: (1) the bacteria were air borne, (2) the bacteria were in the tissues between the skin surface and the external oblique aponeurosis.

Since it is obviously impossible to eliminate air borne contamination entirely, the only way by which it can be proved irrelevant is to show that the flora obtained from cultures of operating room air during operation is different from the flora obtained from cultures taken from the body below the level of the skin surface. In investigating possible sites of contamination, we have done cultural work on the air, skin, and deep skin layers.

We will present the results of our experiments in such order that they can most readily be understood, the order of presentation being: (1) bacteria of the air; (2) bacteria of the skin surface; (3) bacteria of deep skin layers; (4) bacteria of the peritoneal cavity, in cases both with and without intra-abdominal inflammatory reaction.

BACTERIOLOGICAL TECHNIQUE

Before we present these figures, we wish to say a word concerning the methods used and to call attention to the fact that we have tried to keep our results in as simple a form as is consistent with accuracy. We decided to use the classification recommended by Bergey which has been tentatively accepted by the Society of American Bacteriologists, and have classified all organisms according to it, except in the case of the streptococci, which are differentiated according to the more satisfactory system of Holman. In many of the cultures yielding more than one species of

[1] Read before the Surgical Section of the New York Academy of Medicine, March 3, 1933.

organism we did not attempt identification beyond tribe or genus. Many bacteria were found which were unidentifiable beyond the heading of genus because of variations in morphology or cultural characteristics. Therefore, no attempt has been made to subdivide all the genera into species. Some bacteria seen in smear were not identified at all.

We also wish to call attention to the fact that we do not make any statements as to the pathogenicity of the organisms identified, as we believe that this is such a moot question and involves so many highly technical problems it is beyond the scope of the present presentation.

Various media and procedures were used during the 3 years of this study. The following method proved most satisfactory and practicable. It was used in the majority of peritoneal cultures. Obvious departures for different tissues are indicated in the text.

Swabs. Swabs are placed in large, plugged test tubes, wrapped in a towel—sterilized in a hot air oven and then autoclaved.

Technician. The technician is scrubbed, gowned, and gloved as for an operation.

Taking cultures. The peritoneum is lifted and incised with a carbolized knife. Each swab is saturated with peritoneal fluid and quickly replaced in the test tube. Cultures of general peritoneal fluid were taken as soon as the peritoneum was incised. Cultures obtained from the serosa of inflamed organs were taken as soon as the organ was identified.

Bacteriological methods. The swabs were taken to the laboratory immediately. The fluid on each swab was rinsed off into aerobic (plain beef infusion broth pH 7.6) and anaerobic (preheated glucose liver broth) media. A smear of each swab was made and the swab discarded. These smears were stained with gram stain, and the morphology and staining properties of any bacteria in the smear were noted. The anaerobic media was sealed with one-half inch of a mixture of one part paraffin to one part vaseline.

The inoculated tubes were incubated at 37 degrees C., for from 24 hours to 3 weeks depending on the (1) presence or absence of bacteria in original smear, (2) morphology of bacteria in original smear, (3) the period of time required for evidence of growth, (4) the amount of bacterial growth. When there were no bacteria in the original smear and no evidence of growth, the inoculated tubes were incubated for 3 weeks, then smears made and examined, before a report of "no growth" was made.

The bacteria that grew were

1. Streaked on 5 per cent rabbit blood agar plates for color and reaction on blood of aerobes.

2. Heated to 80 degrees C. for 20 minutes to isolate *spore bearers.* The heated culture was: (a) streaked on plain agar for aerobes; (b) put in preheated glucose liver broth, litmus milk, and gelatin; sealed—for anaerobes.

The smears were checked to determine whether or not the organisms isolated by these procedures represented all the types seen in smears. Special procedures, enrichment, etc., were used to try to get forms seen in smear but which were either anaerobic non-spore-bearers or had been overgrown by associated organisms.

The isolated bacteria were put on whichever of the following special media that was indicated for its final identification, according to Bergey's *Manual* and Holman's *Classification of Streptococci:*

Aesculin broth (containing sodium taurochocolate) to differentiate micrococcus ovalis from pneumococci.
Litmus milk.
Gelatin.
Potassium nitrate broth (for nitrite production test).
Sugar-free semi-solid—1 per cent carbohydrate—serum (for fermentation).

Lactose	Salacin
Glucose	Mannite
	Sucrose

Casein digest fluid.
Kendall's "K" medium.
Potato-glycerin juice.
Lead acetate semi-solid agar.
5 per cent washed sheep cells.
Glucose liver broth:
1 pound liver boiled 15 minutes in 1000 cubic centimeters of 1 per cent glucose broth. Filter broth; adjust to pH 7.7. 10 cubic centimeters of broth on small cube of the liver in tall tube. Autoclave.

BACTERIA OF THE AIR

A study was made of the bacteria found at various times in the air of the operating room and laboratory. Blood agar plates were exposed for periods of 30 minutes to 1 hour and 30 minutes during the course of a surgical procedure. These plates were placed as near the operative field as possible, and left exposed for the duration of the operation. Cultures of laboratory air were obtained by the same method of exposing blood agar plates on the laboratory desk while cultural work was in process.

TABLE I

Genus	Synonym	Operating room air, per cent	Laboratory air, per cent
Corynebacterium	Diphtheroids	28.4	35.8
Staphylococcus, Micrococcus, Sarcina		63.8	59.0
Streptococcus		0.6	....
Bacillus	Aerobic spore bearing rods	2.58	3.9
	Colon-typhoid group	2.58	....
Unidentified		....	2.2

From the figures in Table I it is seen that the bacterial flora of operating room and laboratory air is essentially the same. Over 90 per cent of the bacteria recovered in both instances lie in the Micrococceæ tribe (Micrococcus, Staphylococcus, Sarcina) and Corynebacterium genus (diphtheroids).

Of these Micrococceæ only 5 per cent were hæmolytic. This groups them in the parasitic genus staphylococcus (8). The others, 95 per cent, fall into the facultative parasitic or saprophytic genera of Micrococcus and Sarcina. Morphologically and culturally these groups are readily differentiated.

These figures when compared to a similar bacteriological study of portions of the human body differ so markedly that false positive results due to contamination from air borne bacteria can be definitely eliminated.

BACTERIA OF UNPREPARED ABDOMINAL SKIN

These skin cultures were taken from hospital bed patients on whom no skin preparation was attempted. The abdomen was exposed, the skin surface rubbed with swabs which had been autoclaved in broth.

TABLE II

Genus	Synonym	Operating room air, per cent	Unprepared abdominal skin, per cent
Corynebacterium	Diphtheroids	28.4	23.6
Micrococcus, Staphylococcus		63.8	37.2
Streptococcus		0.6	8.6
Clostridium	Anaerobic spore bearing rods	0	21.7
Bacillus	Aerobic spore bearing rods	2.58	8.6
	Colon-typhoid group	2.58	0

It will be noted that between the unprepared abdominal skin surface and air there is a marked change in the bacterial flora. Many more streptococci and anaerobic spore bearing rods appear on the skin surface.

The increased numbers of the spore bearing rods and streptococci on abdominal skin is not surprising, for in this location bacterial growth is greatly favored by darkness, warmth, and moisture.

BACTERIA OF PREPARED ABDOMINAL SKIN

Our method of skin preparation consists of shaving the skin and cleaning with green soap and water the night before operation. At the time of operation, the abdomen is scrubbed with ether both horizontally and longitudinally until the gauze swab used comes away perfectly clean. The skin is then painted with MBGV-5 (5 per cent methylene blue, 5 per cent gentian violet, in 50 per cent alcohol) until it is deeply stained over an area 2 inches wide on each side of the site of the incision. The surrounding surface is then painted with 2 per cent iodine.

Cultures taken from areas painted with MBGV-5 for periods of 10 to 60 minutes have all been negative. A complete report of this experiment was published in 1929 (6).

Our continued use of this technique from the date of the previous publication to the present time has justified in every respect the confidence which we then held in it.

In discussing the fact that all cultures taken from the skin surface after the application of this technique have been negative, the argument has been advanced that in obtaining the cultures some of the dye must necessarily be picked up on the swab and carried over to the culture media. Thus the media becomes a weak antiseptic solution and is no longer a proper media for the growth of bacteria. As

TABLE III

Genus	Synonym	Operating room air, per cent	Unprepared abdominal skin, per cent	Prepared abdominal skin	Knife blades, per cent
Corynebacterium	Diphtheroids	28.4	23.6	0	39.3
Staphylococcus		63.8	37.2	0	17.0
Streptococcus		0.6	8.6	0	10.6
Clostridium	Anaerobic spore bearing rods		21.7	0	8.5
Bacillus	Aerobic spore bearing rods	2.5	8.6	0	2.1
	Colon-typhoid group	2.5		0	9.5
Fusiformis				0	1.0
Actinomyces				0	2.1
Micrococcus ovalis	Enterococcus			0	2.1
Miscellaneous unidentified				0	7.4

the small amount of dye which is carried over goes into solution, the resultant mixture is extremely weak. Our previous experiments have shown that MBGV-5 cannot be relied upon as an effective antiseptic agent when its strength is less than 1 per cent. Therefore, this extremely weak solution is not an effective antiseptic and the argument immediately falls into the discard.

BACTERIA OF THE DEEP SKIN LAYERS

All agree that absolute skin sterilization as deep as the superficial fascia is impossible due to the fact that the hair follicles and sweat glands harbor bacteria and their depths are inaccessible to any known sterilizing agent short of searing or charring. Having come to the conclusion that by using the previously described pre-operative skin preparation technique we are able to obtain a sterile surface field, we next made cultures from the knife blades with which we made our skin incision through this sterile field. With a sterile skin surface and a sterile knife blade whatever bacterial growth is obtained must come from the area through which the knife blade has been passed.

A Bard-Parker knife was used. The skin incision was made as deep as the upper layers of the subcutaneous tissues. The knife blade was immediately detached from the handle by using a clean sterile clamp and the blade dropped into culture media. Both aerobic and anaerobic media have been used. Of the knife blade cultures so taken 70.9 per cent have been positive. For the purpose of comparison, Table III shows the flora of operating room air, of unprepared abdominal skin, of prepared abdominal skin, and of knife blades (deep skin layers).

From a study of this table it is readily apparent that a field has been opened in which the bacterial flora is entirely different from any of those previously studied. There is a marked decrease in the staphylococcus genus and new groups appear.

In this situation the flora is widely diversified and is so entirely different from that of operating room air, unprepared abdominal skin, or prepared abdominal skin, that the possibility of contamination from any one of these three is eliminated.

The question immediately arises as to the source of these bacteria. If it were the exterior, the general flora must be necessarily similar in character to that found in air or on the skin surface. This is not true. The bacteria may be harbored in the sweat glands and hair follicles, or they may be present in all the body tissues or they may represent a combination of these two possibilities. In order to investigate this question the bacterial flora of some deeper structure which can be entered without the possibility of external contamination must be studied. The position of choice for obtaining such cultures is from within the peritoneal cavity. This serous cavity can be approached without opening and may be opened when and with whatever technique is desirable.

BACTERIA OF THE PERITONEAL CAVITY

Cultures were obtained from the fluid of peritoneal cavities by the following technique. The parietal peritoneum was exposed and carefully isolated by sterile towels. A small fold of this membrane was caught between two sterile hæmostatic forceps and held away from the underlying structures. Between the points of these hæmostats a drop of concentrated phenol was smeared; then a small incision was made with a sterile knife dipped in concentrated carbolic acid. The edges of the incision were separated so that a sterile swab could be placed in the peritoneal cavity without touching any structure until the swab was imbedded deep within the cavity. Since the peritoneal cavity normally contains a small amount of serous fluid, dry swabs were used to collect the material for cultures. Both aerobic and anaerobic cultures were made. By this method we feel certain that all the bacteria obtained were in the peritoneal cavity before it was incised and that no contamination occurred. By the use of a carbolized knife any bacteria which may have been present on the outer surface of the peritoneum were immediately killed so that at the time a swab was passed through this serous layer, the cut edges of the incision, with which it might conceivably come in contact, were sterile.

In many instances cultures were taken from the serosa of the organ for which the operation was being performed. We have thereby obtained intraperitoneal cultures both from the site of the pathological process and at a distance from it.

The pathological conditions for which operations were performed and from which cultures were taken are classified under five main headings. Cases of appendicitis comprise groups 1, 2, and 3. The classification depends on whether or not the local condition was active and progressive (group 1), active but non-progressive (group 2), or dormant (group 3) (7).

Operations performed for other intra-abdominal conditions were classified as to inflammatory pathology (group 4), and non-inflammatory pathology (group 5).

We classify, as of inflammatory origin, all cases in which a study of the temperature, white blood cell count, and intraperitoneal gross pathology show that the etiological factor has produced an active combative reaction, both general and local. A rise in temperature, increase in total white cell count, increase in the percentage of polymorphonuclears, and a shift to the left of the polymorphonuclears, local tenderness and rigidity, an increased amount of intraperitoneal fluid, together with local œdema, redness, and other signs of inflammatory reaction are the criteria which guided us. Cases in which all of these phenomena are presented in increasing severity, we call active and progressive. Cases in which these phenomena are presented as static, we call active, non-progressive. Cases in which the phenomena are in recession, we call active retrogressive. Cases in which none of the phenomena are presented, we classify as non-inflammatory in origin.

We have adopted this classification because it is comparatively simple from a clinical standpoint and by it we are able to get uniform opinions among ourselves. The cases are not put into these groups until after the operation, so that the surgeon is guided not only by the clinical manifestations, but by the gross pathology at the time of the operation. The actual operative procedures herein reported were done by various members of the staff of the Fifth Avenue Hospital. The bacteriological studies were done with no knowledge of the clinical picture of the case.

The classification of appendiceal cases, (groups 1, 2, and 3) are approximately accurate. In groups 4 and 5, however, a discrepancy arises which makes classification difficult. Such conditions as subacute or chronic cholecystitis, chronic salpingitis, etc., may be classified as inflammatory conditions since they are undoubtedly originally produced by bacterial activity. Or they may be classified as non-inflammatory conditions because at the time of operation they are free from all evidences of bacterial inflammatory reaction. We have included all such cases in the miscellaneous intra-abdominal inflammatory group (group 4).

In group 5 are included only cases of uterine fibroids, cystic ovaries, retroversions, etc., the causation of which is beyond all question *not*

due to bacterial invasion, and in which no combative inflammatory reaction is present.

By this method of classifying into two groups there can be no doubt cast upon our findings in group 5. It represents the clean peritoneal cavity in which there is no indication of intraperitoneal inflammatory reaction either clinically or on gross examination.

TABLE IV

Group	No. cases	No.+Cult.	No.−Cult	%+Cult.	%−Cult.
1	47	42	5	89	11
2	21	16	5	76	24
3	52	38	14	73	27
4	38	30	8	78	22
5	51	39	12	76	24

Group 1: Active progressive appendicitis—inflammatory.
Group 2: Active non-progressive appendicitis—inflammatory.
Group 3: Dormant appendicitis—non-inflammatory.
Group 4: Miscellaneous inflammatory conditions.
Group 5: Miscellaneous non-inflammatory conditions.

Table IV shows the number and the percentage of positive and negative cultures of peritoneal fluid taken from all classes of cases. Except for group 1, which included many cases of ruptured appendices and advanced active progressive inflammatory processes, in each instance the percentage of positive cultures is practically identical. In group 1, of course, the percentage is higher, as would be expected. These results show definitely that the presence of bacteria within the peritoneal cavity is not dependent upon the presence or absence of an active intraperitoneal inflammatory lesion. Almost as many positive cultures are obtained from the clean as from the dirty or contaminated peritoneum.

TABLE V

	Groups 1, 2, 4	Groups 3, 5	All
Cases	106	103	209
+Cultures	78	77	155
−Cultures	28	26	54
%+Cultures	73.7	74.8	74.1
%−Cultures	26.3	25.2	25.9

Groups 1, 2, 4—Total inflammatory conditions.
Groups 3, 5—Total non-inflammatory conditions.

The figures in Table V point definitely toward a truth which so far has not been generally accepted. It shows the presence of bacteria in what was previously believed to be a sterile area. There are as many positive cultures in non-inflammatory as there are in inflammatory conditions. It is true that the bacteria found in the two types of cases differ as would be expected, and yet many of the same bacteria are present in both types of pathological conditions.

Whenever the bacteriology of the peritoneum is discussed, the question of sex is always raised. Since there is direct communication between the peritoneum and the exterior in the female, it is presumed that bacteria can more easily obtain access in this sex. To forestall this contention, we have prepared Table VI which divides each group into male and female patients and shows the percentage of positive cultures obtained in each sex. We find that the percentage of positive cultures in males is 79.5 per cent, and in females 82 per cent, a difference of 2.5 per cent in 222 cases—an insignificant variation.

TABLE VI

	Male	Female
Cases	86	136
+Cultures	71	108
%+Cultures	82	79.5
−Cultures	15	28
%−Cultures	18	20.5

In Table VII is shown the relative preponderance of bacteria in the two classes of conditions, together with the flora of the knife blades in each group and of the serosa of the inflamed organ in the inflammatory group.

By study of Table VII we find that the numbers of diphtheroids is practically identical whether the intraperitoneal lesion be inflammatory or non-inflammatory. The relative number of diphtheroids found in the peritoneal cavity is practically identical with the number found from cultures of the knife blades.

The knife blade cultures are practically identical for both the inflammatory and non-inflammatory lesions.

In the presence of active inflammatory reactions, there are double the number of streptococci that there are where such reaction is not present.

The incidence of colon bacillus in active inflammatory reactions is nearly three times that found in non-inflammatory conditions. This, of course, is readily explained since in

TABLE VII

Genus	Synonym	Inflammatory conditions Groups 1, 2, 4			Non-inflammatory conditions, Groups 3 and 5	
		Knife blade	Peritoneum	Serosa of inflamed organ	Knife blade	Peritoneum
Corynebacterium	Diphtheroids	41.6	32.7	34.3	41.5	37.7
Fusiformis		0.	0.	1.7	1.9	1.0
Actinomyces		0.	0.6	0.	3.8	0.
Staphylococcus	Hæmolytic staphylococcus	11.1	5.5	5.1	15.0	11.2
Micrococcus	Non-hæmolytic staphylococcus	0.	3.0	0.	5.6	1.0
Streptococcus		8.3	12.9	10.3	7.5	6.1
Micrococcus	Enterococcus	5.5	4.9	6.8	0.	3.
Neisseria	Catarrhalis	0.	0.6	0.	0.	1.
Undetermined cocci		2.7	2.4	0.	0.	4.
Clostridium	Anaerobic spore bearing rods	2.7	9.2	5.1	11.3	14.2
Bacillus	Aerobic spore bearing rods	8.3	4.9	6.8	5.6	9.1
Pseudomonas	Pyocyaneus	0.	3.	3.4	0.	0.
Escherichia	Bacillus coli	11.1	14.1	20.6	5.6	5.1
Proteus		0.	0.6	0.	0.	0.
Salmonella	Paratyphoid	2.7	0.	1.7	0.	1.
Eberthella	Typhoid	0.	0.6	0.	0.	0.
Alcaligenes		0.	1.8	0.	0.	0.
Bacteroides	Anaerobic non-spore bearing rods	5.5	1.8	3.4	1.9	3.
Undetermined rods		0.	0.6	0.	0.	3.

These figures are the percentages of all bacteria cultured.

the majority of these cases we are working with inflamed appendices and the Bacillus coli, a normal inhabitant of this portion of the gastro-intestinal tract, could readily invade and penetrate inflamed intestinal walls, even though it might not be the etiological factor.

The groups of aerobic and anaerobic spore bearing rods show greater numbers in non-inflammatory than in inflammatory conditions. At first glance, these findings are the antithesis of what might be expected. By reviewing in detail the cases in which these organisms were isolated a probable explanation becomes apparent.

It is an established fact that the anaerobic spore bearing rods are found at all times within the lower gastro-intestinal tract. It is also an established fact that within the body these bacteria do not produce spores. It is also known that the rods themselves are easily killed and that it is due to the spores that the genus lives even through most unfavorable circumstances (3, 9). Since we find 14.2 per cent of these organisms present in non-inflammatory and only 9.2 per cent in inflammatory conditions, it seems probable that the presence of active inflammatory reaction, since it is a combative phenomenon, tends to destroy this type of bacteria. If this is true in active inflammatory conditions we should not find anaerobic spore bearing rods but very occasionally. On examining the patients with active inflammation in which these bacteria were found, we see that in practically every instance the inflammation had progressed to the point of necrosis of the organ involved. The presence of necrosis, therefore, appears to be the determining factor as to whether or not these bacteria are found in the presence of active inflammatory reaction. In the cases of appendicitis, anaerobic spore bearing rods were recovered 14 times. In 12 of these cases it is definitely stated in the report of the surgeon and the

TABLE VIII, GROUP I

Case No.	Knife blade	Peritoneal fluid	Serosa of organ
33	Corynebacterium flavidum	Corynebacterium flavidum	Corynebacterium flavidum
35	Corynebacteria	No growth	Corynebacteria Staphylococcus epidermitis Streptococcus fæcalis Escherichia coli
37	Escherichia coli Micrococcus ovalis Bacilli	Micrococcus ovalis Escherichia coli Bacilli	Escherichia coli Micrococcus ovalis Bacilli
38		Corynebacteria	Corynebacteria
40	Corynebacterium hofmanni	Corynebacteria hofmanni	
42	No growth	Corynebacteria	Corynebacteria
43	Unidentified cocci	Escherichia coli Corynebacteria	Escherichia coli Corynebacteria Fusiformis
44	Corynebacterium hofmanni	Corynebacterium hofmanni	Corynebacterium hofmanni
45	Staphylococcus albus	Staphylococcus albus Micrococcus ovalis Escherichia coli	Micrococcus ovalis Escherichia coli
47	No growth	Corynebacterium hofmanni	Corynebacterium hofmanni
48	Clostridium	Clostridium	
51	Bacillus subtilis	Bacillus subtilis Escherichia coli Staphylococcus albus	Bacillus subtilis Escherichia coli Corynebacteria

Note: Group 1—In 6 cases in this group the relationship shown in this table is not found.

TABLE VIII, GROUP II

Case No.	Knife blade	Peritoneal fluid	Serosa of organ
77	No growth	Corynebacteria	Corynebacteria
78		Pseudomonas aeruginosa Corynebacteria	Pseudomonas aeruginosa Corynebacteria
79	Bacteroides	Bacteroides	Bacteroides
68	Corynebacterium hofmanni	Corynebacterium hofmanni	Corynebacterium hofmanni
71	Corynebacteria	Corynebacteria	Escherichia coli
56	Staphylococcus albus Bacillus subtilis	Staphylococcus albus Corynebacterium pseudodiphtherium Clostridium tertium	

Note: Group 2—4 cases in this group do not show the relationship shown in this chart.

pathologist that gangrene was present at operation. It seems, therefore, that these bacteria are frequently present in the body tissues in limited numbers and attenuated forms; that the presence of active inflammatory reaction readily inhibits their growth so that they are not recoverable; but that in the presence of necrosis, in which instance they can get a foothold in dead tissue, they again are found, become virulent, and invade. This contention is supported by the experiments of Andrews, Rewbridge and Hrdina who found that when finely chopped sterile meat was injected into the peritoneal cavity of a guinea pig the animals were rapidly invaded by anaerobic spore bearing rods and death occurred within a short interval of time (20 hours).

In comparing the flora of the peritoneal fluid and the serosa of the organ in inflammatory conditions, it is to be noted that the figures are almost identical. In practically every instance the figures for serosa of the organ are slightly higher than those for general peritoneal fluids. It is particularly true in the type of bacteria which is normally found in the

TABLE VIII, GROUP III

Case No.	Knife blade	Peritoneal fluid	Serosa of organ
108	Corynebacterium hofmanni Clostridium welchii	Corynebacterium hofmanni Clostridium welchii Bacillus —	Corynebacterium hofmanni Clostridium welchii Bacillus —
111	No growth	Bacteroides	Bacteroides
114	Corynebacterium —	Corynebacterium — Escherichia coli	Corynebacterium — Escherichia coli
117	Escherichia coli	Micrococcus ovalis	Micrococcus ovalis
119	Streptococcus fæcalis	Streptococcus fæcalis	Streptococcus fæcalis Alcaligenes —
99	Staphylococcus citreus	Staphylococcus citreus Corynebacteria Colon-typhoid group	Corynebacteria Colon-typhoid group
100	Staphylococcus albus Fusiformis	Salmonella — Corynebacteria	Fusiformis Salmonella — Corynebacteria
101	Clostridium tertium	Clostridium tertium	Clostridium tertium
102	Staphylococcus albus	Staphylococcus albus Streptococci	Staphylococcus albus Streptococci Escherichia coli
131	Colon-typhoid group Streptococcus equinus	Colon-typhoid group	Streptococcus equinus
124	Streptococcus subacidus	Streptococci subacidus	Streptococcus subacidus
107	Clostridium tertium Escherichia coli	Clostridium tertium	Clostridium tertium Escherichia coli Streptococcus equinus
105	No growth	Streptococci (anaerobic)	Streptococci (anaerobic)

Group 3—8 cases did not show this type of relationship.

lower portion of the gastro-intestinal tract. This is to be expected, for whatever bacteria are found at the site of an intraperitoneal inflammatory process must necessarily be spread by means of the fluid content of the peritoneal cavity and the peristaltic action of the intestines.

In 106 unselected cases we have obtained cultures from at least 2 and in many instances all three positions: deep skin layers, peritoneal fluid, and serosa of the organ. These cultures are of particular interest when comparisons are made in the same case. Table VIII shows in detail the bacteria found in representative cases, from each group. Of the 106 cases in which we have two or more cultures, we find the identical bacteria at more than 1 site in 85 instances. This relationship is therefore shown in 80.1 per cent of the cases. It is particularly interesting to note that in most instances the bacteria which are found within the peritoneal fluid or on the serosa of the organ are frequently identical to the bacteria which are isolated from the knife blades. When we remember that the knife blade cultures were taken before even the superficial fascia had been incised and that possible contamination has been eliminated, it becomes apparent that these bacteria must have been in the skin before the operation was undertaken. Many of these cultures show the presence of diphtheroids which is not surprising, but it is extremely suggestive to know that in many cases in which the colon bacillus is found at the serosa of the organ it is also disseminated in the peritoneal fluid and is found to be present in the skin as well. Such are the facts.

CONCLUSIONS

1. Our studies lead us to believe that in 80 per cent of instances a growth can be obtained from cultures taken from within the peritoneal cavity.

2. This is true, whether the patient be male or female, and irrespective of the clinical evidence of the presence of intraperitoneal inflammatory reaction.

3. The character of the flora from within the peritoneal cavity differs markedly from that obtained from the air.

4. We believe that there is no such thing as intraperitoneal asepsis.

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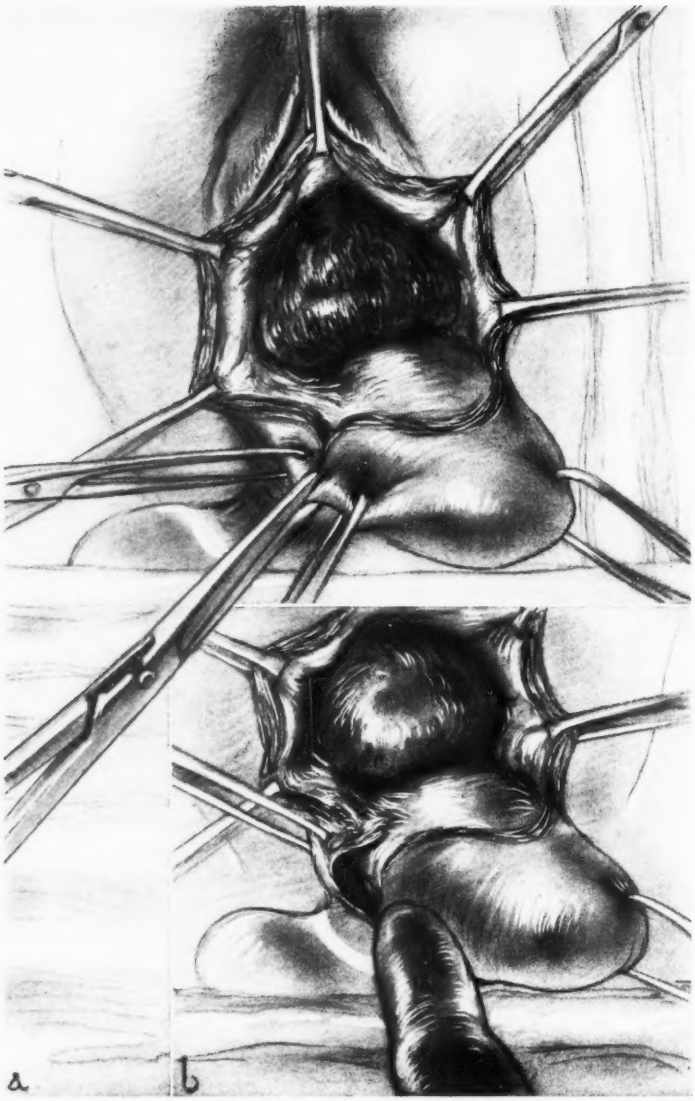

Fig. 2. a, The bladder has been separated from its abnormal cervical and vaginal attachments. The lateral incision of the vaginal wall. b, The approach to the transverse cervical ligament.

An Evaluation of the Bissell Operation for Uterine Prolapse.—Byron H. Goff.

CLINICAL SURGERY

FROM THE CLINIC OF THE WOMAN'S HOSPITAL

AN EVALUATION OF THE BISSELL OPERATION FOR UTERINE PROLAPSE

A Follow-Up Study[1]

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IN 1918, Dougal Bissell presented before the American Gynecological Society a verbal description of an operation for prolapse of the uterus in women past the menopause and in younger women who have the more marked degrees of prolapse or prolapse associated with uterine pathology. Between the years 1919 and 1932, this procedure has been employed in 116 cases operated upon by the members of the Second Gynecological Division at the Woman's Hospital in the State of New York. Since the patients so treated have been under follow-up observation for a period of 13 years it is interesting to evaluate this operation now on a follow-up basis. To appreciate fully the conclusions drawn from such a study it is necessary to consider briefly the fundamental anatomical and physiological facts and theories upon which the operation has been based.

NORMAL ANATOMY OF UTERINE SUPPORT

An extensive experience in dissections on the cadaver and in operations on the living subject has convinced Bissell that the uterus is maintained at a normal level in the pelvis by the visceral portion of the fascia endopelvina which extends inward from the sides of the pelvis and is attached to the cervix at the level of the internal os. He feels certain that the most important parts of this fascia are those which are located in the bases of the broad ligaments beneath the ureters and the uterine vessels, and which have been termed the transverse cervical or cardinal ligaments. These "ligaments" are composed of fibro-elastic connective tissue which, as it approaches the cervical attachment, interdigitates with smooth muscle fibers from the uterine musculature. The posterior part of the visceral layer of the fascia endopelvina which is attached to the back of the cervix also aids in the support of the uterus while the anterior portion of the fascia (vesicovaginal areolar fascia) plays no part in uterine support because of its frail structure.

Blair Bell and Goff have published photomicrographs of histological cross sections from the vesicovaginal septa in normal nulliparæ which show that the vesicovaginal portion of the fascia endopelvina is composed of an insignificant layer of loosely arranged fibro-elastic connective tissue the supportive properties of which are negligible. Recently Koster, who has studied histological cross sections from the vesicovaginal and rectovaginal septa in a normal multipara, has found the areolar fascia in both of these septa identical with that in nulliparæ.

NORMAL PHYSIOLOGY OF UTERINE SUPPORT

With students of intra-abdominal and intrapelvic pressure, Bissell agrees that there is an antagonistic action between the muscles which surround the abdominal cavity and those which close the pelvic outlet, and, that this action may create pressure conditions in the pelvic and abdominal cavities which influence the position of the viscera. Despite the plausibility of this theory he feels that there are clinical facts which cannot be reconciled with it, and therefore, regards the function of the pelvic floor (levatores ani muscles and fasciæ) as a factor of no importance in normal uterine support.

PATHOLOGICAL ANATOMY OF UTERINE PROLAPSE

Since Bissell believes that the transverse cervical ligaments are fundamentally responsible for the maintenance of the uterus at a normal level, he reasons logically that the basic etiological fac-

[1]Read before the American Gynecological Society, May 10, 1933.

Fig. 1. a, The opening of the anterior vaginal wall. b, The entrance to the line of natural cleavage between the vaginal and bladder walls.

tor in the development of prolapse of the uterus is either a congenital defect in, or an injury to, these fascial structures. Similar lesions in the part of the fascia endopelvina which is attached to the back of the cervix may also be factors in the development of uterine prolapse, but are of less importance.

In all degrees of uterine prolapse, the transverse cervical ligaments are elongated, hypertrophied, and are drawn out in a fan-shaped formation as they reach their cervical attachment.

The part of the fascia endopelvina which forms the floor of the cul-de-sac of Douglas may, as a result of injury or congenital defect, become the site of a hernial ring through which a true hernial sac may protrude to pass downward between the posterior wall of the vagina and the wall of the rectum. It is to be borne in mind that such a hernia may occur in association with uterine prolapse or as an independent entity with a uterus in normal position. This part of the fascia when not herniated may become elongated in cases of uterine prolapse with the result that the cul-de-sac is abnormally deepened. This deepening may predispose to hernia of the cul-de-sac.

The uterosacral ligaments which bound the cul-de-sac laterally show no consistent change associated with uterine prolapse. In some instances they are markedly hypertrophied while in others they are attenuated into frail strands of smooth muscle.

The part of the fascia endopelvina which is situated between the transverse cervical and the uterosacral ligaments is elongated in proportion to the degree of the prolapse.

In most cases of prolapse of the uterus there is an hypertrophic elongation of the cervix which may or may not be associated with circular hypertrophy of the cervical musculature. In cases of first or second degree prolapse these changes may be more pronounced than in the complete variety. The mechanism which is responsible for these cervical changes has not been satisfactorily explained.

The condition of the body of the uterus in cases of prolapse is variable. Because of the age of the patient in whom prolapse most frequently occurs a senile uterus is the type usually found. It has long been taught that a retroversion of the body of the uterus is invariably associated with uterine prolapse. In a long clinical experience Bissell has observed a considerable number of patients in whom the uterus was prolapsed and at the same time anteverted. Tandler and Halban describe a similar combination of uterine prolapse associated with anteversion of the uterine body.

When considering the pathological anatomy of uterine prolapse it is of the greatest importance to keep in mind the possibility of a kinking of the ureters caused by the downward angulation of the overlying uterine vessels. That such kinking does occur and that it is frequently responsible for hydro-ureter and hydronephrosis with serious damage to the kidney has been demonstrated by Brettauer and Rubin in a study made in 1923. Tandler and Halban have also called attention to this complication of uterine prolapse.

PATHOLOGICAL PHYSIOLOGY OF UTERINE PROLAPSE

The importance of functional impairment of the musculature of the pelvic floor in the etiology of uterine prolapse is a moot subject. Some authors consider it as the principal factor in the causation of this condition while others are of the opinion that it has little or no influence on the position of the uterus. Bissell is of the opinion that it plays no part in the development of uterine prolapse and bases that opinion on two clinical facts: (1) prolapse of the uterus occurs in nulliparæ who have normal function of the pelvic floor; (2) the uterus remains in a normal position permanently in innumerable women who have marked functional impairment of muscles of pelvic floor.

Fig. 3.

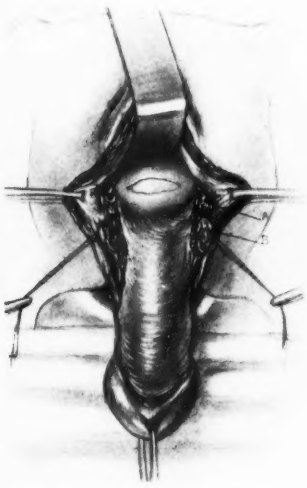

Fig. 4.

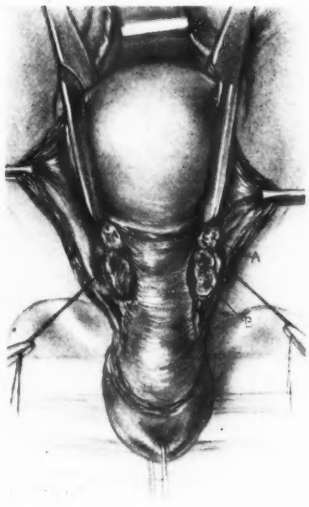

Fig. 5.

Fig. 3. The ligation of the transverse cervical ligament and uterine vessels.

Fig 4. The incision in the uterovesical fold of peritoneum. *A*, The ligated uterine vessels. *B*, The ligated transverse cervical ligaments.

Fig. 5. The separation between clamps of the round, broad, and utero-ovarian ligaments and the uterine tubes from the uterine body is accomplished. *A*, Indicates the ligated uterine vessels; *B*, ligated transverse cervical ligaments.

BISSELL OPERATION FOR UTERINE PROLAPSE AND CYSTOCELE

Incision of the anterior vaginal wall (Fig. 1, a). The portion of the vaginal wall which covers the prolapsed uterus and cystocele is bisected by a very superficial lateral incision (in the vaginal

Fig. 6. Ligation of round, broad, and utero-ovarian ligaments and the uterine tubes, *d*. Ligation of uterosacral ligaments, *c*.

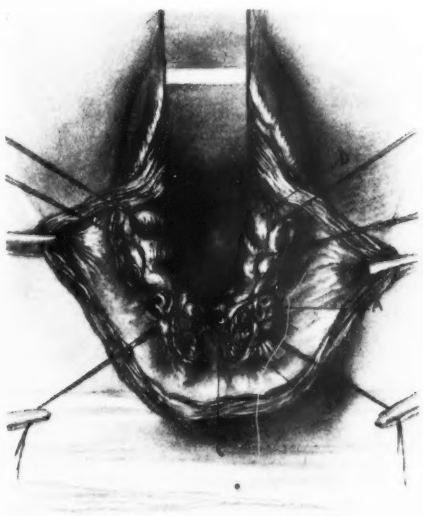

Fig. 7. *A*, The ligated uterine vessels. *B*, The ligated transverse cervical ligaments. *C*, The ligated uterosacral ligaments. *D*, The ligated round, broad, and utero-ovarian ligaments and uterine tubes.

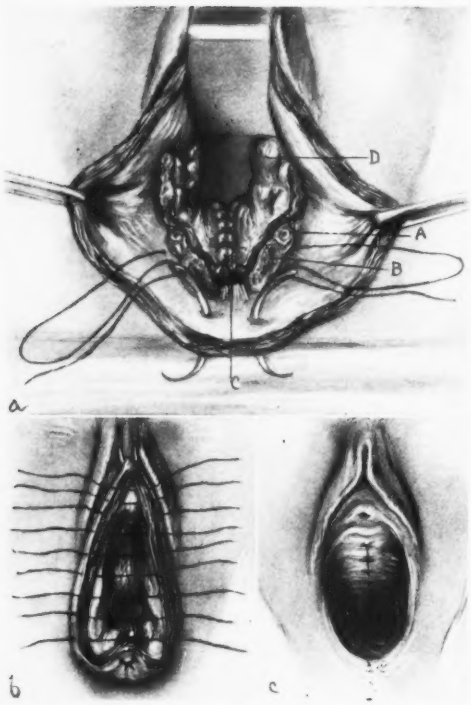

Fig. 8. a, The attachment of the transverse cervical and uterosacral ligaments, *B* and *C*, to the posterior vaginal wall. The obliteration of the cul-de-sac by the union of the uterosacral ligaments, *C*. b, Excision of vaginal wall for correction of cystocele.

mucosa) into an anterior and a posterior half. This incision acts as a landmark which facilitates a symmetrical final closure of the anterior vaginal wall. An equally superficial circular incision is made in the vaginal mucosa at the cervicovaginal junction. In the line of this incision the vaginal wall is opened by a scissors which cut through the vaginal wall (mucosa and muscular coat) to the vesicovaginal areolar fascia. The incision so made forms an artificial pocket, Figure 1, b, which is bounded by the vaginal wall, the cervix, and the bladder. This pocket is lined with an extremely thin layer of areolar connective tissue (the vesicovaginal areolar fascia) some of which clings to the muscular coat of the vaginal wall and the remainder to the muscular coat of the bladder and the musculature of the cervix.

The vesicovaginal areolar fascia marks the line of natural cleavage between the vaginal wall, the cervix, and the wall of the bladder. Because of its frail structure it cannot be dissected as an individual layer, and is worthless in the surgical correction of either cystocele or prolapse of the uterus. This portion of the fascia endopelvina is in no way involved in the etiology of cystocele or uterine prolapse.

Separation of the bladder from the cervix and vaginal wall (Fig. 2, a). Following the separation of the bladder wall from the vaginal wall in the midline by a gauze covered finger, the anterior vaginal wall is bisected in the sagittal plane from the cervicovaginal junction to the point where the urethra enters the wall of the bladder. The bladder is then separated from its abnormal cervical and vaginal attachments along the line of natural cleavage to the level of the uterovesical fold of peritoneum.

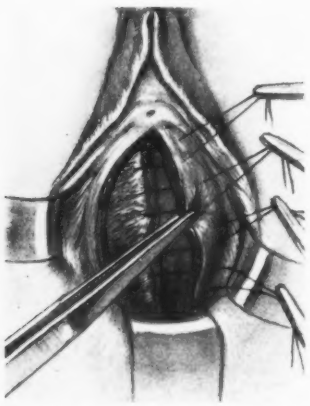

Fig. 9. Bissell lapping operation for cystocele.

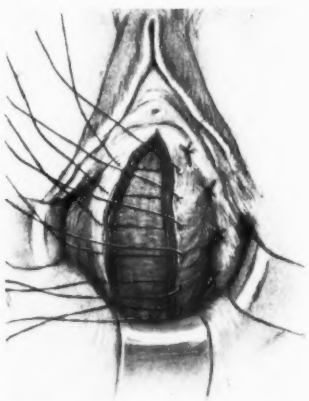

Fig. 10. Bissell lapping operation for cystocele.

The approach to the transverse cervical ligaments (Fig. 2, a and b). An incision is made with scissors through the lateral vaginal wall at the level of the cervicovaginal junction. This incision passes through the vaginal wall to the areolar fascia which separates it from the musculature of the cervix. The pocket formed by this incision is enlarged by the introduction of the scissors so that the index finger of the operator may be introduced and pushed upward behind the transverse cervical ligament as far as the uterine vessels.

Ligation of the transverse cervical ligament and uterine vessels (Fig. 3). The transverse cervical ligament, which in cases of uterine prolapse is markedly elongated and hypertrophied, is ligated by means of interrupted mattress sutures the upper one of which may be made to include the uterine vessels. The uterine vessels are ligated on the uterine side also. The ligament and the vessels are separated from the uterus close to the side of the cervix. The opposite side is treated in a like manner. It will be noted that so far the peritoneal cavity has not been opened. This approach to the transverse cervical ligaments has two advantages over the usual technique of vaginal hysterectomy: (1) It facilitates the recognition and ligation of the transverse cervical ligaments, and (2) it prevents early contamination of the peritoneal cavity.

The delivery of the body of the uterus from the peritoneal cavity (Fig. 4). The uterovesical fold of peritoneum is cut transversely, and the body of the uterus is delivered from the pelvic cavity through the peritoneal incision. At this point a strip of iodoform gauze is placed in the cul-de-sac to absorb any blood that may leak into the pelvic cavity from the site of operation.

Separation of the body of the uterus from its ligaments and the tube (Fig. 5). The broad, round, and utero-ovarian ligament and the uterine tube are grasped between the jaws of a Bissell hysterectomy clamp, and are separated from the uterus. The protecting gauze is then removed from the cul-de-sac.

Ligation of the uterosacral ligaments (Fig. 6). At this point the cul-de-sac is examined for hernia or abnormal depth. The uterosacral ligaments are ligated close to their uterine attachments by sutures which include the fascia endopelvina on either side of and between them. The broad, round, and utero-ovarian ligaments and the tube are ligated by interrupted interlocking mattress sutures.

Separation of the uterus from the uterosacral ligaments, the fascia endopelvina, and the posterior vaginal wall (Fig. 7). The uterus is separated from the uterosacral ligaments, the part of the fascia endopelvina which is attached to the back of the cervix, and the posterior vaginal wall. All of the parts of the fascia endopelvina which were originally attached to the sides and back of the cervix plus the uterosacral ligaments are now held by ligatures.

Obliteration of the cul-de-sac (Fig. 8, a). If there is a hernia of the cul-de-sac the hernial sac is removed and the cul-de-sac is obliterated by suturing the uterosacral ligaments together in the sagittal plane from their cervical attachments to a point just in front of the rectum. A deep cul-de-sac is also obliterated as a prophylactic measure against the development of a postoperative hernia of the cul-de-sac.

Attachment of the fascia endopelvina to the vagina (Fig. 8, a). The transverse cervical ligaments, the portion of the fascia endopelvina which was originally attached to the back of the cervix, and the uterosacral ligaments are sutured to the upper end of the posterior vaginal wall at a common point in the sagittal plane just in front of the cul-de-sac. It is obvious that all of the fascia endopelvina which originally gave support to the cervix is now attached to the vaginal vault. It is also apparent that there is no potential hernial point in the vault of the vagina.

The broad and round ligaments are allowed to retract. Before 1913, Bissell experimented with the interposition of the broad and round ligaments between the bladder and the vaginal wall beneath the pubic arch in the treatment of cystocele, but abandoned it because it had a tendency to draw the transverse cervical ligaments downward and forward with the result that there was created a potential hernial point in the vault of the vagina.

Operation for cystocele (Fig. 8, b). The cystocele which is usually associated with uterine prolapse may be treated by: (1) excision of the redundant part of the vaginal wall, or (2) by the Bissell lapping of the anterior vaginal wall.

1. The redundant portion of the anterior vaginal wall is excised as illustrated in Figure 8, b. The excision is triangular in shape with the apex of the triangle at the urethra and the base in the vaginal vault. The cut edges of the vaginal wall are approximated by interrupted sutures. A small rubber tissue drain is placed in the upper angle of the wound. The peritoneal cavity is not closed by suturing the peritoneal cut edges together.

2. The Bissell lapping of the anterior vaginal wall (Fig. 9). The mucous membrane is removed from the right half of the vaginal wall by means of an Emmet scissors. The denuded muscular coat is then drawn beneath the left half of the vaginal

TABLE I.—AGES

	Cases
31 to 35 years	4
36 to 40 years	10
41 to 45 years	10
46 to 50 years	27
51 to 55 years	25
56 to 60 years	16
61 to 65 years	11
66 to 70 years	9
71 to 75 years	2
76 to 80 years	2

TABLE II.—PARITY

	Cases
Nulliparæ	6
i-para	16
ii-para	14
iii-para	9
iv-para	18
v-para	4
vi-para	7
vii-para	5
viii-para	3
ix-para	1
x-para	3

wall by interrupted mattress sutures of chromic catgut as illustrated in Figure 9. The cut edge of the left half of the vaginal wall is sutured to the right side of the vagina as illustrated in Figure 10.

The Bissell operation for cystocele was originally termed fascia lapping operation. As a result of histological studies of the tissues which have been regarded as fascia by many authorities on vaginal plastic surgery, Bissell (3) has been convinced that the so called fascia is in reality the muscular coat of the vaginal wall, and published his findings in 1929 under the title: "Fascia Lapping as Applied to the Tissues of the Vaginal Wall, a Misnomer."

Operations on the pelvic floor. Anatomical and functional defects in the pelvic floor associated with uterine prolapse are corrected by suitable methods in all cases. These procedures are performed, however, for the relief of the symptoms caused by the lesions in the pelvic floor and not essentially as a part of the treatment of uterine prolapse.

The present study includes 116 cases of prolapse of the uterus in which the patients were operated upon by the members of the Second Gynecological Division at the Woman's Hospital. All patients were subjected to the same anteoperative study, the same pre-operative preparation, and the same postoperative care, all of which are standard in the Woman's Hospital. In every case the procedure was performed precisely as described by Bissell. Because of the refusal of 23 patients to return for follow-up examination and the loss of 7 patients by postoperative death, the end-result analysis has been based on the findings in 86 cases which have been under follow-up observation for periods ranging from 1 to 8 years.

TABLE III.—SYMPTOMS

	Cases	Per cent
Vaginal protrusion	86	100
Vaginal discharge	42	48.8
Frequency of urination	32	37.2
Dysuria	17	19.7
Urethral incontinence	12	13.9
Dragging sensation in pelvis	14	16.2
Sacral backache	10	11.6
Metrorrhagia	6	9.3
Rectal pain	1	1.1

PHYSICAL FINDINGS AND CLINICAL PATHOLOGY

A perusal of the pre-operative physical examination and clinical pathological reports in 116 cases under consideration shows them to have been women within normal limits for their respective decades of life with few exceptions. There were 3 cases of marked myocarditis. One patient had in addition to a severe chronic cystitis a large calculus in the bladder. Three patients showed a marked functional hypertension. There were 3 cases of pronounced secondary anæmia.

AGE

The ages of the 116 patients operated upon are shown in Table I.

In the 86 cases studied in the follow-up, it is an interesting fact that there were 6 nulliparæ in each of whom there was a prolapse of the uterus. There were 2 cases with third degree prolapse, 2 cases of second degree prolapse, and 2 cases of first degree prolapse of the uterus. In 1 patient who had a third degree prolapse there was a history of a fall from a scaffolding at the fourteenth year which was immediately followed by a vaginal protrusion. In all of the others the histories and physical examinations failed to reveal any cause other than probable congenital defects in the fascial supports of the uterus. In no case had there been any detectable injury of the musculature of the pelvic floor.

CHARACTER OF DELIVERIES

Of the 80 patients who had borne full term children, 60 (75 per cent) had been delivered spontaneously and 20 (25 per cent) had been delivered by operative procedures.

DIAGNOSES

When classifying the degrees of uterine prolapse it is important to consider some definite

TABLE IV.—DIAGNOSES

	Prolapse of uterus 1st degree	Prolapse of uterus 2nd degree	Prolapse of uterus 3rd degree
No cystocele (3)	1	1	1
Cystocele			
Small (4)	2	2	0
Medium (45)	21	22	2
Large (34)	5	23	6
Relaxation of pelvic floor (15)	6	5	4
Laceration of pelvic floor (10)	4	6	0
Rectocele—small (20)	8	12	0
Rectocele—medium (34)	9	23	2
Rectocele—large (6)	1	2	3
Deep cul-de-sac of Douglas (6)	1	5	0
Hernia of cul-de-sac of Douglas (4)	0	2	2

TABLE V.—SUMMARY OF TABLE IV

Prolapse of the uterus	Cases
First degree	29
Second degree	48
Third degree	9
Cystocele	83
Relaxation of the pelvic floor	15
Laceration of the pelvic floor	10
Laceration of the pelvic floor with rectocele	60
Deep cul-de-sac	6
Hernia of the cul-de-sac	4

uterine landmark in its relationship with various levels in the pelvis. In this series of cases the internal os has been taken as a landmark. When the uterus has descended so that the internal os is at the mid point of the vagina as the patient strains, the prolapse has been termed first degree. When the internal os is at the level of the vulva, the prolapse has been termed second degree, and when the entire body of the uterus has passed beyond the introitus, the prolapse has been termed third degree (Table IV).

There were 3 cases of uterine prolapse without cystocele. An analysis of Table IV gives the totals shown in Table V.

There were 3 cases in which there was no cystocele. The vaginal wall was excised in 2 cases and lapped in 1 case as a prophylactic measure against the development of cystocele.

There were 16 cases in which no operation was considered necessary because of the slight degree of relaxation or laceration. One case had had a perineal operation elsewhere.

ANÆSTHETIC

The anæsthetic employed in 84 cases was ether with a nitrous oxide induction. In 1 case spinal anæsthesia was given and in 1 case nitrous oxide-oxygen gas anæsthesia.

POSTOPERATIVE RECOVERY AND COMPLICATIONS

The average postoperative rise in temperature including all of those due to complications was

TABLE VI.—OPERATIONS

	Cases
Operation for prolapse of uterus and vaginal vault	86
Operation for cystocele (lapping of vaginal wall)	55
Operation for cystocele (excision of vaginal wall)	31
Operation on pelvic floor (Emmet operation)	12
Operation on pelvic floor (Levator myorrhaphy)	13
Operation on pelvic floor (Goff operation)	43
Operation on pelvic floor (lapping vaginal wall)	1

TABLE VII.—COMPLICATIONS

	Cases	Per cent
Infections		
Anterior vaginal wall	2	
Posterior vaginal wall	2	
Vault of vagina	1	
Incidence		5.8
Surgical shock	3	3.4
Pyelitis	3	3.4
Rectovaginal fistula	1	1.1

101.7 degrees which returned to normal on the sixth postoperative day.

With the exception of 2 complicated cases (51 and 107 days), the average number of postoperative days in the hospital was 21.

It was necessary to catheterize the bladder from 1 to 13 days. The indwelling catheter was not used in any case.

MORTALITY

In 116 patients operated upon there were 7 deaths (6 per cent). Bacteriæmia was the cause in 2 cases, cardiac collapse in 2 cases, surgical shock in 2 cases, and bronchopneumonia in 1 case.

The mortality rate in the series of cases under consideration is high for any vaginal plastic procedure. This has been due to the fact that operative treatment has been employed in 3 cases which were known to be poor operative risks. In each case the risk was explained to the patient and to her relatives, and, non-operative methods of treatment having failed, operation was elected by the patient as the only means of relief from symptoms which had become unbearable.

When considering a justifiable mortality in patients who have been subjected to vaginal hysterectomy for prolapse of the uterus one should keep in mind the fact that many women who have this condition are not only past middle life but have some general systemic disease. In the light of these facts it is obviously of the greatest importance to subject all such patients to more thorough physical examinations of the cardiovascular and urinary systems and to be guided by the findings in such examinations when making a decision for or against the employment of a major vaginal plastic operation, if the mortality rate is to be kept at a justifiable level.

TABLE VIII.—PATHOLOGY

	Cases
Cervix	
Hypertrophy	86
Laceration	38
Erosion	19
Chronic cervicitis	25
Polyp	2
Corpus	
Normal	14
Atrophy (senile)	52
Myomata	11
Polyp	6
Hyperplasia of endometrium	3

PATHOLOGY

A perusal of the reports by the pathologists at the Woman's Hospital in the 86 cases under follow-up study showed the conditions in the uterine body and cervix as outlined in Table VIII.

It is obvious that the uterine body was either atrophied or diseased in 83.7 per cent of the 86 cases. The average length of the cervix was 6.6 centimeters in cases of first degree prolapse, 7.1 centimeters in cases of second degree prolapse, and 7.1 centimeters in cases of third degree prolapse.

END-RESULTS

Inasmuch as follow-up studies which are based on letters from patients or statements of general practitioners are not only worthless but are misleading, all such evidence has been eliminated from the study of the series of cases under consideration. In every case herein reported the patient has been subjected to a vaginal examination by one or more of the members of the Second Gynecological Division at the Woman's Hospital. In many instances all members of that staff have recorded their findings in the case. When making such examinations both symptomatic and anatomical conditions have been taken into consideration, and in any instance in which there has been any doubt as to the end-result a consultation with some other member of the division has been sought by the examiner.

The period of follow-up study has varied from 1 to 8 years as follows: 36 cases were followed for at least 1 year, 9 cases for 1½ years, 23 cases for 2 years, 2 cases for 2½ years, 8 cases for 3 years, 2 cases for 3½ years, 2 cases for 4 years, 2 cases for 5 years, 1 case for 6 years, and 1 case for 8 years.

Since prolapse of the uterus, cystocele, relaxation of the pelvic floor, laceration of the pelvic floor with and without rectocele, and hernia of the cul-de-sac of Douglas are conditions which occur individually or in combination, the results which have followed the operation for each condition are reported separately in Table IX.

TABLE IX.—ANATOMICAL END-RESULTS

	Cases	Success per cent	Failure Cases	Failure Per cent
Vaginal hysterectomy for prolapse of uterus and vaginal vault	86	98.9	1	1.1
Operation for cystocele				
Lapping vaginal wall	55	96.0	2	4.0
Excision vaginal wall	31	93.6	2	6.4
Operation on pelvic floor				
Emmet operation	12	33.3	8	66.7
Levator myorrhaphy	13	86.7	2	13.3
Goff operation	43	95.6	2	4.4
Lapping vaginal wall	1	100		
Obliteration of deep cul-de-sac	6	83.3	1	16.7
Obliteration of cul-de-sac (for hernia)	4	50.0	2	50.0

TABLE X.—SYMPTOMATIC END-RESULTS

	Cases	Complete relief per cent	No relief Cases	No relief Per cent
Vaginal protrusion	86	89.6	9	10.4
Vaginal discharge	42	88.0	5	12.0
Frequency of urination	17	94.1	1	5.0
Urethral incontinence	12	75.0	3	25.0
Dragging sensation in pelvis	14	100.0		
Sacral backache	10	90.0	1	10.0
Metrorrhagia	8	100.0		
Rectal pain	1	100.0		

All failures have been apparent within the first 6 months of follow-up observation.

CONCLUSIONS

1. The uterus is maintained at a normal level in the pelvis by the visceral part of the fascia endopelvina, especially by those parts of the fascia which are termed the transverse cervical or cardinal ligaments.

2. The basic cause of uterine prolapse is either a congenital defect in or an injury to the transverse cervical ligaments.

3. Functional impairment of the musculature of the pelvic floor plays no part in the etiology of uterine prolapse.

4. A successful surgical correction of uterine prolapse must be based on a shortening of the elongated transverse cervical ligaments.

5. Symptom producing abnormalities of the pelvic floor associated with uterine prolapse should be corrected by suitable surgical procedures, but such procedures should not be regarded as essential in the treatment of uterine prolapse.

6. The advantages of vaginal hysterectomy in the treatment of uterine prolapse over other methods are: (1) it facilitates the shortening of the transverse cervical ligaments, (2) it facilitates the correction of abnormalities of the cul-de-sac of

Douglas, (3) it removes a uterus which is either useless or abnormal in over 80 per cent of cases, and (4) it removes the future possibility of neoplastic disease of the uterus.

7. The use of vaginal hysterectomy in the treatment of uterine prolapse should be confined to (1) patients past the menopause whose physical condition warrants a major surgical procedure, and (2) younger women who have the more marked degrees of uterine prolapse or prolapse associated with uterine pathology.

8. In addition to the usual physical examination, all patients with uterine prolapse should be subjected to a complete pre-operative urological examination for both anatomical and functional abnormalities of the ureters and kidneys which may be secondary to uterine prolapse and cystocele.

9. Spinal and caudal anæsthesia should be used more frequently in cases subjected to vaginal plastic operations.

10. More rigid pre-operative studies, more care in the selection of the anæsthetic to be used, and an expedition of the operation should reduce the mortality of vaginal hysterectomy to 2 per cent or less.

11. In the series of 86 cases subjected to follow-up study the prolapse of uterus and vaginal vault has been successfully corrected in 98.9 per cent of cases.

12. Cystocele treated by the Bissell method of lapping the vaginal wall has been successfully corrected in 96.0 per cent of cases.

13. Cystocele treated by excision of the redundant vaginal wall has been successfully corrected in 93.6 per cent of cases.

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DISLOCATIONS OF THE CERVICAL SPINE

Their Complications and Treatment

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REPORTED dislocations of cervical vertebræ vary in number from a single instance to Langworthy's notable series of 30 cases of dislocation with no demonstrable fracture, seen over a period of 9 years. The writer has had occasion to see and handle 40 cases of dislocation of the cervical spine, with and without fractures, during the last 4 years. Seventeen of these have been previously reported elsewhere (3, 4). The number is not large enough to permit a dogmatic attitude, but results have been such as to allow the endeavor to set forth in orderly fashion the obstacles and complications encountered in the entire series.

Table I, giving the origin of the dislocations and the results, is self-explanatory. Table II, giving the complications encountered, is the basis of further remarks. The shallow, horizontal facets existing between the atlas and the axis account for the predominance of displacement at this point. By the same token, this is the most easily reduced dislocation. It also gives the most anxiety in reduction by reason of the ever haunting fear that the odontoid may be damaged. This should not cause the surgeon to postpone reduction until a possible fractured odontoid has united, as has been suggested by one writer (9). Without reduction, the odontoid will probably unite in malposition. In any case, the union will not be sufficiently firm to remove the risk of reduction.

Fractures of vertebræ constitute the most frequent complication of dislocation. While fracture was demonstrated in only 12 of this series, I believe that it occurs much more frequently than can be demonstrated. Moore goes so far as to say "by general consent, fracture is considered an inevitable accompaniment of a dislocation and it should be considered as present whether or not it can be demonstrated by an X-ray examination." This seems an extreme stand after noting some of the apparently simple dislocations in our experience. On the other hand, X-ray examination showed chip fractures to exist in the apparently simple rotary dislocations of Cases 22 and 27. This is another reason for early reduction. Callus formation may make accurate reduction impossible, even though fracture has not been visible. In the neck, anatomical accuracy is essential for function, comfort, and union.

Associated fracture of other bones calls for the usual care of the secondary injury. It may be possible to include the lesser fracture in the plaster cuirass for the neck injury. This was successfully done in the fracture of the humerus in one case. It would scarcely seem necessary to warn against overlooking the associated fracture because it is overshadowed by the spine injury.

Injuries to the cord were observed in only 3 cases. Two patients died as the result of injury. The third was Case 35. One attempt at correction failed and further efforts were not permitted by the mother. The child had also cerebral involvement which made it difficult to determine the amount of actual cord damage. This unusually small percentage of cord injuries must be due to the absence of diving accidents in the series. The lay press has noted a large number of diving injuries to the neck with more or less paralysis. The writer has observed several such patients. The immediate cause of death is usually drowning, simply because the paralyzed swimmer cannot bring himself to the surface and is not rescued until too late. Schmieden may have had such cases in mind when he stated that in three-fourths of all cases of dislocation of cervical vertebræ death occurs immediately or soon after the accident as the result of high paralysis of the cord. Otherwise, it is impossible to see how such a high mortality could occur. In this series there were 2 deaths from the injury, or 5 per cent.

The damage is done at the moment of impact. With the release of the causative force, the bones of the spinal canal tend to return to their normal relationship, decreasing their impingement upon the spinal cord. The paralyses are caused by the transitory intrusion into the canal of displaced bone or by the pressure of extravasated blood within the dura. This seems to be agreed by all men seeing more than an occasional instance of this injury. It explains the futility of laminectomy, as asserted by Taylor after seeing the result of laminectomy with a literal explosion of the cord contents upon incising the thick walls of the dura. Davis and Voris have reported the findings in a cord that has been irreparably damaged by a

dislocation that replaced itself, so that no malposition of the spinal column was found either by X-ray or at autopsy. The writer agrees with Taylor that prompt and complete reduction of dislocation by closed manipulation offers the best prospect of recovery from cord injuries.

The absence of cord injury at the time of examination does not warrant minimizing the injury or neglecting the care of the patient. The records of two fatal results were brought to my attention during the past year, because of failure to protect dislocations in which cord symptoms had not yet appeared. These patients were brought to different hospitals because of injuries to arms or legs. Both had fallen downstairs. One developed weakness in the right arm. Routine X-ray examination revealed forward fracture dislocation of the sixth cervical vertebra with impingement on the spinal canal. She refused to have any reduction or immobilization despite the careful explanation by the resident surgeon. Five minutes later she suddenly went into coma and died. This was 12 days following the injury. There was no new injury, she merely moved her head and the cord was destroyed. We must remember that the body of the vertebra had also begun to soften by this time in the course of fracture repair.

The second woman entered the institution a few hours after falling down several steps. She was semi-conscious and hysterical, but deep and superficial reflexes were normal. She complained of pain in head and neck. X-ray examination revealed fracture dislocation of the first and second cervical vertebræ. Before correction or immobilization had been applied, the patient became comatose and died less than 24 hours after entering the hospital. In an earlier paper (4) it has been stated that these injuries demand more prompt attention than an acute abdominal condition.

Injuries to the cervical roots are of more frequent occurrence; they were seen in 9 of the series. They are usually due to pressure and the patients recover when the dislocation is reduced and pressure relieved. If there is associated fracture, the possibility of callus impinging upon the nerve root is always present and is another argument for thorough reduction of the displacement and complete immobilization of the head and neck. A rather common symptom of dislocation of the atlas is pain along the distribution of the greater and lesser occipital nerves, persisting after reduction of the long standing cases until the damaged nerve trunk has recovered. Occasionally the damage is permanent in neglected dislocations, or in the associated fracture and callus cases.

TABLE I

TYPE OF TRAUMA

Falls	
Downstairs	10
From roof	2
From ladder	1
Stumble	7
Auto accidents	5
Football accidents	1
Wrestling accidents	2
Blows on head	5
Caught in car door	1
Standing on head	1
Cultist manipulation	1
Violent rotation of head	4
	40

CHARACTER OF VIOLENCE

Self-inflicted accident	24
Outside trauma	16
Occupational accident	7
Home or vicinity	22

LOCATION OF DISLOCATION

First cervical	20
Second cervical	10
Third cervical	3
Fourth cervical	2
Fifth cervical	4
Sixth cervical	1
	40

NATURE OF DISLOCATION

Unilateral	29
Bilateral	11
	40

RESULTS

Attempted reduction	37
Complete reduction	28
Partial reduction	8
Failure of reduction	1
Deaths from reduction	0
Deaths from injury	2

Associated injuries to soft tissues may of course be manifold. The vast majority are of secondary importance In 2 of our patients, Cases 20 and 21, the burns about the face, neck, and chest were so extensive that no effort to reduce the dislocated neck could have been successful, even had the condition been recognized at the time. Laymen and surgeons as well considered the deformities to be due to scarring of skin and soft tissues of the neck. Reduction of the displacement of the neck corrected in large part the scar distortion as well. Dr. Brown then restored full usefulness of the impaired arm function by the use of split skin graft (2). It has been suggested that Case 17 might be one of the type described by Berkheiser and Seidler as "Non-traumatic Dislocations of the Atlanto-Axial Joint," in which the dislocations were ascribed to respiratory tract

TABLE II.—COMPLICATIONS OF DISLOCATION

	Cases
Demonstrable fractures of vertebra	12
Associated fracture of other bones	1
Injuries to cord	3
Injuries to cervical roots	9
Associated injuries to soft tissues	3
Congenital anomalies	2
Redislocation	4
Lapse of time	
More than 1 week	21
More than 6 weeks	12
6 months	1
9 months	2
11 months	1
12 months	1
15 months	1
21 months	1
Degree of displacement	
Mild	11
Severe	24
Extreme	5

infections. The writer believes that such infections render the limiting tissues of the neck more pliable and dislocation more probable following a sneeze, cough, or other minor violence. In this particular instance, the patient had undergone tonsillectomy, anæsthesia, and such chances for inadvertent rotation of the sick neck.

Congenital anomalies of the cervical spine added to difficulties of diagnosis and treatment in 2 of our cases. Case 21 had synostosis of the first and second vertebræ. An unusually long spinous process made rotation of the dislocated second cervical impossible until the process had been cut away. This is the only case in the series receiving open operation of any sort. The actual reduction was accomplished by closed manipulation at a later date. Case 33 had elevation of a scapula, Sprengel's deformity. In this instance Dr. E. W. Spinzig, the roentgenologist, stood his ground and insisted that dislocation existed despite inconclusive clinical findings. After manipulation the radiological and clinical pictures confirmed his original opinion.

To determine the incidence of deformities of congenital origin that might be expected in clinical practice, the necks of 200 skeletons were examined, in the collection of Dr. Robert J. Terry, professor of anatomy, Washington University School of Medicine. The relatively numerous pathological fusions of two or more vertebræ were eliminated. Six, or 3 per cent, of actual congenital deformities were found. One was an articulation of the odontoid process with the axis. Five were synostoses of different adjacent vertebræ. One specimen was a true case of so called "Klippel-Feil" syndrome (10). This particular skeleton would have presented a real problem for diagnosis and accurate reduction had he sustained a cervical dislocation in life. The incidence of congenital anomalies is not large enough to constitute a major problem in dislocation, but should be kept in mind in the diagnosis and treatment. Nor should the error be made of calling a traumatic dislocation a congenital deformity, as was done in at least two of the cases that have come to my knowledge. After such a diagnosis it is difficult to convince the patient that correction can be accomplished and also difficult to protect the good name of the preceding physicians.

Pathological bone conditions may complicate or actually bring about luxation of a vertebra. Destructive spondylitis may cause malformation sufficient to permit the slipping of one or more vertebræ. Such diseases as hypertrophic arthritis and tuberculosis are the most frequent offenders in this respect.

Lapse of time has been a prominent complication of this series, adding much to the difficulties of correction (Table II). The previously mentioned complications cannot be reduced in severity, they simply have to be met as they come. The time element can and should be reduced in such a serious matter as dislocation of the neck. The economic feature is evident. The dangers are obvious, and have been mentioned. I cannot say what should constitute the time limit for attempting reduction. The fact that Case 40 with extreme bilateral dislocation could still be reduced without killing the patient, after 1 year's time would almost lead one to believe that there is no time limit in so called simple dislocation without demonstrable fracture. The only one I have refrained from attempting by reason of lapse of time was a man with typical wry neck and history of dislocation due to a fall from a cherry tree 35 years ago. X-ray pictures by Dr. D. W. Patterson, Port Huron, Michigan, showed rotation of the atlas and axis with compensatory scoliosis of the lower cervicals and various traumatic arthritis changes.

Long continued deformity in a growing child leads to maldevelopment of the bony tissues and after a time there is a structural scoliosis not amenable to correction. Some have stated that dislocations tend to correct their wry necks. In our experience, such is not the case. The compensatory scoliosis does not eradicate the deformity. On the contrary, the lateral bowing and rotation of the cervical spine become more noticeable with the atrophy of the soft tissues on the downward side of the head and neck. These tissues are not spastic as in toxic or congenital torticollis. They are flaccid, being thrown out of use by the

fact that the tilting of the head is due to a definite bony block. The opposing muscles on the sound side of the neck are kept taut by their increased length and effort to bring the head back to its normal position.

Elimination of this distressing complication rests with the clinicians who see the cases in their early days of disability. "Demonstration of the unilateral dislocations remains a challenge to the roentgenologist" (11). It is likewise true that the greater responsibility remains with the clinical observer. He must make his own examination and, after careful consultation with the roentgenologist, draw his own conclusions. X-ray examination is imperative but should not be the final word. Sometimes the roentgenological picture is not conclusive, but is corroborative of signs brought out by careful physical examination. Many of the long duration cases had been to numerous physicians, surgeons, radiologists, and cultists. Diagnoses had varied from rheumatism and infantile paralysis to nervousness. In some cases the correct diagnosis had been made and then the patient was advised that nothing could be done. MacKinnon states that "Fractures and dislocations of the spine are common enough to be of interest to the general practitioner." Twelve of his 50 cases were in the cervical region. We have seen other cases for which no adequate treatment was given, apparently because the attending physician was at a loss what to do. The condition is frequent enough and its consequences serious enough to demand accurate diagnosis and adequate treatment.

Redislocation is an embarrassing and distressing complication, occurring four times in this series. Case 33 was the result of the patient's own misdemeanors, two were due to insufficient support by the cast, and one, Case 39, followed premature removal of the cast. Each of these recurrences was easily corrected again and put up accurately to prevent further trouble.

An essential feature in the prevention of redislocation, particularly in cases of long standing, is to overcorrect, bringing the head and neck into hyperextension, so that the articular processes are firmly seated home in their corresponding facets. Hyperextension must be maintained over a varying, but long, period of time. Not only does overcorrection insure complete reduction, but it stretches the ligaments that have contracted on the anterior aspect of the vertebræ, thus preventing their drawing the vertebra out again by sheer force of their contraction.

Treatment must be immediate and thorough. Delay invites tragedy and adds to the difficulties. Of the various manipulative procedures, Walton's retrolateral flexion with rotation and Taylor's immediate traction with manual manipulation stand out as anatomically and surgically correct. Each has its particular field of usefulness. Not infrequently it has been helpful to supplement one with the other. Reduction with the patient in bed, following with head traction by halter and weights over the head of the bed (16), or head traction and sand bags in lieu of reduction in severe cases (6) is, in my experience, inadequate. A better reduction can be obtained with the patient on a table than on a bed. Full hyperextension of the head and neck over the end of the table is essential as the final step in any technique of reduction. The writer has used any flat table or hospital cart. A strip of steel 4 feet long, 4 inches wide and 3/16 inch thick is placed on the surface, with the end flush with the head of the table. Later, this will furnish support for the shoulders and chest during the application of the plaster cast. The patient is placed recumbent on the table. As soon as he is under the anæsthetic, he is pushed cephalward until head and neck are beyond the head of the table, lying in the operator's hands.

For the Walton technique, one hand is placed alongside of the head on the dislocated side. The other hand is cupped under the chin from the opposite side. That is, the operator stands at the head, facing the table. For a left lateral dislocation of a vertebra, the left articular process having slipped anteriorly on its underlying facet, the operator's left hand lies along the left temple and cheek of the patient. His right hand is cupped around the chin, with the heel of the hand below the angle of the jaw. The head is carefully but firmly rotated to the right, increasing the displacement, to permit of unlocking the bony block that has taken place. There is usually a slight click as this unlocking occurs, but it is by no means constant. The head is held in the position of rotation and flexed laterally to the right, the heel of the hand cupped under the chin being used as an additional help to the anatomical fulcrum of the lateral masses of the vertebræ of the neck. Lateral flexion is carried to the point that the articular process is lifted above the top of the bony block. Still maintaining lateral flexion, the head is rotated back to the left, beyond normal range of rotation, until the operator is assured that full correction has been secured. Usually a second "click" is palpable and may be audible as the process clears the obstruction in the facet. The head is then hyperextended and the lateral flexion released. Head and neck must be kept in

extension until the plaster cast has been applied to maintain the position of correction. For a dislocation of the opposite side, the steps of the procedure are the same, but the directions are reversed.

I have used the Taylor method in the bilateral type and in the fracture complications. For the Taylor technique, the halter, or Sayre head sling, is adjusted prior to anæsthesia. As soon as the anæsthetist can give the anæsthetic from one side, the traction belt is adjusted about the operator's waist or hips and hooked to the head sling. The surgeon will need a heavy pad or cardboard over his lumbar region to prevent this belt from cutting uncomfortably into his lumbar tissues. The writer wears an Osgood belt, or lumbar splint, as a matter of comfort and convenience when using the Taylor traction. Traction is maintained for at least 5 to 10 minutes to tire out muscular resistance. For countertraction on the patient's shoulders, muslin bandages 5 or 6 inches wide are placed prior to anæsthesia, one over each shoulder, the ends extending diagonally downward across the chest and the back to the opposite thigh. Each shoulder must be protected by the felt pad anticipated for use with the plaster cuirass. The two ends of each tractor are held by assistants on either side and steady pull maintained to correspond to the traction employed by the operator.

Taylor's original description called for a steady pull in the direction of dislocation, usually anteriorly, until muscular tension had been relaxed and the locked processes extended beyond the level of the bony block. The operator then stepped down from the stool upon which he had been standing, continuing the traction with the head and neck hyperextended over the head of the table and using the surgeon's fingers to lift the lower cervical vertebræ anteriorly. The assistants must maintain countertraction throughout. Several surgeons have modified the technique, using the rotation and side bending of Walton's maneuver during traction. This has real advantages over other reductions described in which the operator uses a steady pull by one means or another and then relies upon anatomical relationships to coax the displacement back into position. The surgeon's hands are free for any indicated manipulation. He must have a definite picture in his mind of the pathological anatomy with which he is dealing and also each step of the reduction. There is usually a very definite sense of "give" or relaxation of the neck spasticity and an audible, or at least palpable, snap as the vertebra slips back into position. After successful reduction it is possible to rotate the head easily toward the shoulder of the side on which the displacement had existed. If rotation cannot be done fully and easily, the correction is not complete and the procedure must be repeated, more force and greater range of manipulation being used.

In cases of long standing, or those with crushing fractures in addition to dislocation, it is necessary to maintain a certain amount of traction until the plaster cast has been completed. With this in mind, the writer has had the head sling made of canvas rather than leather. Canvas is less expensive and not as rigid on the patient's head within the cast. Slings may be improvised from muslin or canton flannel, but leather or canvas made to pattern by a competent maker of orthopedic apparatus are much more satisfactory to the surgeon and comfortable to the patient.

Immobilization is best secured by plaster-of-paris cuirass. The most frequently cited objections are not valid, in my opinion. Any immobilization will be distasteful, but the plaster cast, carefully and accurately applied, offers the maximum of comfort and safety. Stockinette is first applied to chest, neck, and head, the utmost care being used in handling the patient. Felt pads are applied over pressure points of the shoulders, point of chin, and thyroid cartilage. Sheet wadding is smoothly applied in only sufficient quantity to give a smooth lining to the shell that is to follow. More casts are spoiled by excessive sheet cotton padding than by too little. The plaster bandages must be smoothly applied and accurately fitted to the contour of the body, care being used not to pull the bandages and crease the shell. As soon as the plaster has set, the openings for face, ears, and armpits are cut out with a round bellied plaster knife and the margins of the stockinette fitted over the edges of the plaster. Any surgeon who attempts to care for such a serious condition should be equipped to apply a proper cast.

Vomiting will have to be watched for closely. If the cast is ruined in spite of care, a new one can be applied in a few days with much less trouble now that anæsthetic is not required for the reduction itself. In a few cases of simple dislocation, it has been possible to give the patient a brief gas anæsthesia, then allow him to sit up for plaster application as soon as awake. This is not feasible in the more severe cases.

The only special apparatus employed by the writer has been the 4 inch strip of steel mentioned above and a length of gas pipe to support the free end of this back support. The steel is

long enough to extend from the first thoracic vertebra to below the buttocks. Patient and underlying steel strip are drawn off the head of the table to permit the application of plaster around the entire upper trunk. A heavy patient causes considerable sag of the head end of the steel, so a length of gas pipe set in a floor flange is placed under the upper end of the steel strip to support the shoulders on a level with the table. After the plaster sets, the pipe is removed and the steel strip slid down from within the cast, while assistants hold the patient preparatory to moving him to hospital carriage or bed.

Advantages of plaster cuirass are numerous. Immobilization is accurate and not dependent upon variable weight pull or the patient's position in bed. The patient cannot wriggle out of his extension or immobilization. He invariably squirms and tries to ease the pull on his head and neck in any traction over the head of the bed. Such pull is not present in the cast and redislocation is guarded against by dorsiflexion of the neck. Nursing care is simplified. The patient can be moved about in bed, rolled to either side, or lifted, without risk. The surgeon can leave the case with the assurance that his patient is securely held and will not be endangered by any of the possibilities that are ever present in the less positive methods of immobilization. The majority of patients may sit up in bed or in a wheel chair within a few days. Unless contra-indicated by the nature of the lesion, they may walk about, wearing the cast, by the expiration of 3 or 4 weeks. In cases of cord injury, with trophic skin changes, the cast may be bivalved as described by Conwell to permit of attention to the skin.

After-care varies with the severity of the lesion. All cases except the ones seen early and with slight subluxation, will require plaster cuirass for 3 weeks as a minimum. In severe dislocations the minimum time for cuirass is 3 months and an additional 3 months in doll collar. This is also the time required for the neglected displacements of 6 weeks' duration or longer. Thomas collar follows for from 3 to 6 months. In lieu of the plaster doll collar, one may be made of celluloid, where such work can be handled. Otherwise, the doll collar may be bivalved to permit physical therapy.

The after-care with physical therapy is important. Baking or diathermy, massage, and muscle training give much comfort and restore the soft tissues to normal tone and usefulness (8). The muscle training emphasizes the rotation of the head and neck in the direction of correction and in hyperextension particularly. Early in these exercises, care must be taken not to permit the patient to rotate toward the direction of the former displacement. When the time comes that the supporting doll collar or Thomas collar may be omitted for part of the time, such should be done while the patient is fully conscious and aware of his surroundings. While on guard, redislocation is not likely to occur. The support must be worn while patient is asleep or when unexpected jolts or strains may occur, as in riding in automobiles or street cars.

Psychotherapy comes in for its share in the after-care. These patients are apt to suffer from loss of morale. They must be handled with careful consideration for the personality of the patient as well as thoughtful care for the surgical anatomy of the case. The necessity for long continued restriction of use of the neck muscles must be explained to them. They are told that the first rule of safety for them is "chin up" to hold the neck in hyperextension. Sufficient successful results are now on record to furnish a basis for guardedly favorable prognosis.

SUMMARY

The cervical region is particularly predisposed to traumatic dislocation of the vertebræ, displacement of the atlas predominating. Complications are such as are common to other regions of the spinal column, with the addition of "lapse of time." Delay in recognition and treatment of cervical displacement is due to the paucity of nerve pressure symptoms and the difficulty in securing conclusive roentgenograms of the multiple processes and facets of the cervical spine. This paper attempts to set forth the necessity and means for accurate reduction, immobilization, and after-care of this increasingly frequent injury. Immediate and positive reduction by closed technique should be used, followed by full immobilization in plaster cuirass. The fundamental principles of reduction as described by Walton and by Taylor still hold good. Both these writers have been quoted freely and their techniques elaborated in Scudder's notes on dislocations.

The successful reduction of several dislocations of long standing is reported, one being a complete bilateral displacement of the atlas of 12 months' duration. The longest duration of a unilateral dislocation prior to the successful reduction was 21 months.

CASE REPORTS

CASE 20. N. E., white girl, aged 11 years, seen at Shriners' Hospital with Drs. C. H. Crego, Jr., and J. Albert Key. Eleven months previously this girl had been

Fig. 1.

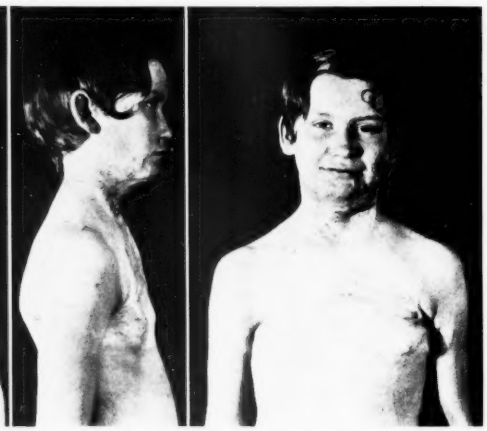

Fig. 2.

Fig. 1. Case 20. The typical deformity of severe unilateral rotary dislocation of the atlas. Cervical scoliosis, lumbar lordosis, collapse of chest, and malnutrition are due to the dislocation, and not to the burns, a fact which is clearly brought out in photographs in Figure 2.

Fig. 2. Same patient as in Figure 1, taken several weeks after reduction of dislocation and prior to plastic work on scars.

severely burned when her clothing caught fire. As is usual, the adults knocked the child to the floor to extinguish the flames. When she recovered sufficiently to move about, her head and neck were terribly deformed (Figs. 1, 3, 4). The head was sharply flexed until the chin rested on the chest. The chin was rotated toward the right. There was kyphosis of cervical spine. Slight rotation was possible toward the right, none whatever toward the left. Dr. J. B. Brown pointed out that the chin and head had been pushed down by forces operating in the spine and not pulled down by soft tissue scars and contractures. He insisted that the spinal pathology be corrected before he perform plastic work on the scars. To my pleased surprise, it proved possible to reduce this extreme dislocation by Walton's technique, on the first attempt, January 26, 1931. X-ray check-up 5 weeks later showed tilting of first on second and slight forward displacement of second on third. Without anæsthetic, Taylor traction was applied, the head hyperextended, and a plaster cuirass was applied (Fig. 8). Cuirass was worn 3 months after first manipulation. Celluloid doll collar worn the balance of a year. X-rays showed perfect reduction. The range of motion was normal in all directions (Fig. 2). Dr. J. B. Brown made plastic correction of scarring (2).

Case 21. P. T., 7 year old girl. Interestingly enough, this child was seen with Drs. Crego and Key at the Shriners' Hospital at the same time as the preceding case, with a similar history of being knocked to the floor when her clothing caught fire, 21 months prior to our observation. Efforts at correction had included thorough trial of head pelvic traction over a period of 2 months. Patient had cervical scoliosis, the chin was rotated toward the left shoulder, the right ear was inclined toward the right shoulder. There was no rotation of head toward the right beyond the midline. Right hemi-facial atrophy was evident. Conclusive X-ray pictures were difficult to get, but indicated rotation of both first and second cervical vertebræ on the right. Attempts with both Walton and Taylor techniques seemed to bring about clinical corrections until the cast was applied, but later observation showed no change. Based on conclusions from X-ray pictures made by Dr. Sherwood Moore that a congenital anomaly existed in the spinous process of the second vertebra, an operation was done on the back of the neck. There was found fusion of lateral masses of first and second on right side, marked enlargement of spinous process of second, which was also fused to spinous process of third, and posterior displacement of left side of second on third. Spinous processes of second and third were cut away to permit movement between these two. After closure, Taylor traction and manipulation was attempted, traction being continued until the cast was applied, but reduction was not complete. In all, 5 attempts at correction were made until on November 19, 1931, 30 months after injury, the posterior displacement of the left side of the axis was corrected and then the anterior rotation of the right side was reduced.

Five months after correction, plaster cuirass was bivalved to permit of physical therapy under the direction of Dr. F. H. Ewerhardt. Eight months following the correction, she had good motion in all directions, but it was deemed wise to continue doll collar for fear the vertebræ may have developed in deformity during the girl's 30 months of displacement preceding the final reduction. Another feature developed, malocclusion due to recessive bite. Dr. Leo M. Shanley considers this to be due to cast pressure on the chin and is taking steps to overcome the condition. The scars fastening her right arm to her chest wall were corrected by a one stage split thickness graft operation by Dr. J. B. Brown (2).

Case 24. J. H., white man of 63 years, referred by Dr. Will L. Freeman of St. Charles, Missouri. On August 24, 1930, he was thrown from a truck, landing in a ditch with neck flexed and another man on top of him. He was treated for contusions and abrasions and an inguinal hernia was operated upon. In hospital, note was made of some pain in the neck, but it was not considered of any great significance. When examined February 19, 1931, he showed the usual signs of incomplete dislocation of the neck, plus pain down the right upper arm. Comparative study of X-ray pictures by Drs. Sherwood Moore and L.

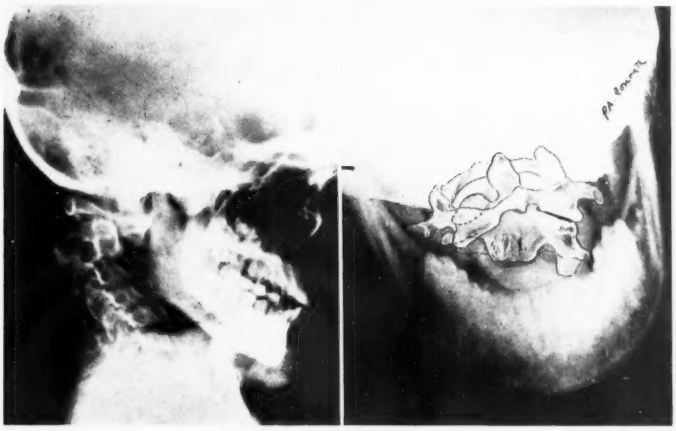

Fig. 3, left. Roentgenogram of same patient as in figures 1 and 2, showing extreme displacement of one side of the atlas with the maximum of rotation of the vertebra and the head. (Compare with Fig. 5.)

Fig. 4. Anteroposterior view of the same case as the preceding figures, taken through the mouth. The X-ray print has been retouched, following accurately the shadows to bring out the actual position of the atlas. The right lateral mass sits in its usual place on the right articular facet of the axis. The left lateral mass lies actually in front of the axis. Compare with Fig. 7.

McCutchen revealed old injury to anterior margin of fifth cervical and anterior displacement of the fifth, of moderate amount. February 28, 1931, at Barnes Hospital, under nitrous oxide gas ether anæsthesia, Walton maneuver was followed by Taylor traction to assure full posterior replacement. A plaster cuirass was applied. Examination as late as March, 1932, showed good rotation, but some limitation of other movements. The result must be classed as only partially successful, due in part to delay in recognition of the condition and in large part to inadequate after-care with physical therapy. This was an industrial case in which the Commissioner was unable to believe that a man could have dislocated neck and not suffer more distress while lying in bed in hospital after his herniotomy. The small amount of pain with the patient quiet is striking in many cases (5). A neurological consultant testified at the hearing that a dislocated neck was bound to give neurological findings. This is contrary to the observation of numerous surgeons. Lessons may be learned from our incomplete results.

Case 26. M. F., white man, aged 26 years, was seen May 4, 1931, at Barnes Hospital, with Dr. Harry Wiese. On the previous day he had dodged a playful blow by his "girl friend," stepped backward suddenly, throwing his head backward and sideways. There was a snap and acute pain in the back of neck. He was unable to sleep that night. On examination, both sides of neck seemed full; he was unable to fasten his usual collar. The chin was tilted slightly downward and a bit to the right. Both sternomastoids stood out in spasm. Tenderness was present to left of second cervical vertebra. No voluntary rotation was possible in either direction. X-ray by Dr. Sherwood Moore showed abnormality between second and third cervical vertebræ. The second spinous process rotated toward the left. Lateral articular process of second appeared to be elevated and rotated so that its inferior tip overlapped the margin of the articular facet of the third. With patient recumbent, neck spasticity and disability continued. During nitrous oxide gas ether anæsthesia, the anæsthetist caught hold of the patient's jaw, elevating it and rotating his head. She noticed that immediately something "gave way" and his head became freely movable. So by a coincidence, the female of the species brought about the dislocation and then reduced it. This reduction was a happy and humorous one, but gives warning that such a disability should not be moved about while under the anæsthetist's care for fear of increasing the dislocation or doing damage to a possible fracture. Examination under anæsthesia showed complete reduction and range of motion. A Thomas collar was applied, and worn for 6 weeks. Physical therapy was given by Dr. F. H. Ewerhardt.

Case 29. J. H., colored man, aged 48 years, was seen at the City Hospital No. 2 through the courtesy of Dr. Roland Kieffer, visiting surgeon, and Dr. H. E. Hampton, resident surgeon. He fell from a ladder to the floor, a distance of 12 feet, striking on his head. He was unable to straighten his head. Tingling and paræsthesia were noted down right arm into fingers. The chin was rotated to the left, the head tilted to the right. X-ray examination by Dr. E. W. Spinzig showed anterior dislocation of the body of the fourth cervical vertebra, for a distance of ⅓ to ½ of its depth. The right articular process was also displaced forward. There were chip fractures of the spinous and articular processes. The day following injury, reduction was accomplished with the technique of Walton by the assistant in surgery, Dr. W. T. Love. X-ray picture corroborated the correction. X-ray examination 4 days later showed redislocation as before. The chin had dropped and rotated during the application of the cuirass, due to the plaster being wrapped in the direction of deformity rather than in the direction of correction. We should have watched this. Patient was in distress, declar-

Fig. 5.

Fig. 6.

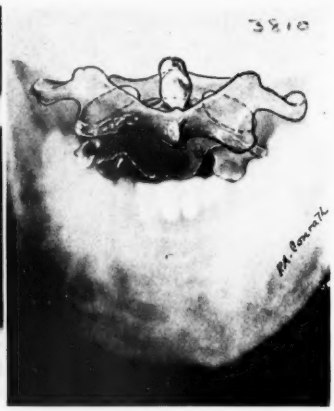

Fig. 7.

Fig. 5. Lateral roentgenogram of Case 40. The body of the atlas lies entirely anterior to the body of the axis. The laminæ of the first are resting on the articular surfaces of the second. This being a bilateral dislocation, the rotation noted in Figure 1 does not occur, both sides of the vertebræ being equally pushed forward.

Fig. 6. Lateral view of patient shown in preceding illustration, taken through the cast after reduction. The body of the first cervical is seated firmly on the second cervical, and the tip of the spinous process is shown to be in normal relationship to the spinous processes of the other cervical vertebræ.

Fig. 7. Same patient as in the two preceding illustrations prior to reduction. X-ray exposure through the mouth. The print has been accurately retouched, following the shadows carefully. The atlas lies below the level of the upper surface of the axis, while the odontoid extends well above the upper level of the atlas.

ing that "something must be done." The cuirass was removed, Taylor traction manipulation was applied without anæsthetic and a plaster cuirass applied in position of correction, chin to right and head extended. Immediately after manipulation patient declared that he felt comfortable. After 1 month, plaster doll collar was substituted for the cuirass. X-ray films showed perfect position.

CASE 32. W. D., colored man, aged 38 years, seen at City Hospital No. 2 through the courtesy of Dr. Heinbecker and Dr. H. E. Hampton. Patient fell downstairs from the second to the first floor on Christmas day of 1931. He entered the hospital the next day, complaining of a stiff, sore neck. Routine X-ray examination showed no definite evidence of injury. The head was held rigid with chin rotated to right and head tilted to the left. Flexion and extension of head and neck were limited. Rotation of chin to the left stopped at the midline. Second X-ray examination by Dr. E. W. Spinzig showed fracture of odontoid process with anterior dislocation of the first cervical vertebra and skull. There were no gross neurological changes. December 30, 1931, under ether anæsthesia no material change in the range of motion was found. Taylor traction was used for reduction, swinging gently toward patient's right shoulder and then rotating head to the left. Following this, equal motion was found in either direction, within the attempted limits. At the end of 4 months, patient was still wearing a collar, had good range of motion, and X-ray picture showed good position.

CASE 33. W. B., colored boy, aged 13 years, entered City Hospital No. 2 on January 22, 1932, because of painful stiff neck. This followed "wrastling" the preceding day, when the second boy fell on the patient's neck. Examination revealed the chin rotated to the left, the head tilted toward the right shoulder, the left sternomastoid prominent, the left shoulder higher than the right due to congenital elevation of left scapula. Head motions were fairly free, with slight limitation toward the right. It was thought that this might be due to the congenital deformity, but Dr. Edgar Spinzig insisted that the X-ray pictures indicated definite, though mild, anterior luxation of second and third cervical vertebræ, of recent origin. January 25, 1932, under ether anæsthesia reduction was brought about by means of Taylor traction, with two definite clicks on extension of the head and neck. A Thomas collar was applied. X-ray examination showed improvement, but still some decrease in normal cervical curve. Walton maneuver, without anæsthesia, corrected this entirely. Patient went home wearing a Thomas collar. He returned in a week because of recurrence of pain in the neck. X-ray examination showed recurrence of deformity with anterior tilting of the second and third cervical vertebræ. Without anæsthetic, the combined Walton and Taylor technique was used. A plaster cuirass was applied, with chin toward the right. X-ray examination revealed normal position. This was an obdurate patient. He destroyed a large portion of his cast by butting his head against the wall and pulling the cast to pieces. The Psychiatric Clinic dealt with him. He was given a plaster doll collar and sent home. April 22, 1932, X-ray examination showed a normal neck.

CASE 36. D. H., 31 year old man, was riding in an automobile that was struck from behind by another car. His head was thrown violently backward then forward. The neck became rigid the next day, but the condition gradually subsided under treatment for "sprained neck." He went out on the road again after 3 weeks, but was unable to hold up to his usual work because of pain in head, neck and back. He was then seen by Dr. Lee D. Cady who found definite paræsthesia of fourth and fifth fingers, right impaired grip in right hand, localized pain along the grea

occipital nerve and tenderness over the left sacro-iliac joint. X-ray films by Dr. Sherwood Moore showed compression fracture of fifth cervical vertebra and rotary dislocation of first cervical vertebra on the right side. The clinical examination showed some limitation of rotation of head toward the right and definite limitation of left lateral flexion of head. There was marked tenderness over the right lateral process of the first cervical. He carried his head slightly tilted to the left. The chin was rotated slightly to the left. The right shoulder was lower than the left. Physical therapy was given for 2 weeks at Barnes Hospital by Dr. F. H. Ewerhardt, in an effort to relax the musculature of the neck and back. At Barnes Hospital, May 16, 1932, just 15 months after the original injury, reduction of the neck was attempted, a modification of Taylor-Walton techniques being used. X-ray examination 4 days later showed no appreciable change in the position of the vertebræ. May 26, 1932, under deep ether anæsthesia, Walton maneuver gave distinct click at unlocking and louder click at moment of correction and seating home of the articular process. This was audible to the entire audience. There was full range of motion in all directions. A plaster cuirass was applied.

CASE 39. A. R., 8 year old girl, referred by Dr. O. C. Hanser. About 3 months prior to observation patient awakened with pain in head and neck and inability to move her head. The history revealed a fall the preceding day while she was playing in the school yard. She had been seen and treated by some eleven physicians and cultists. Diagnoses had been made of infantile paralysis, rheumatism, fracture of neck. One doctor urged removal of tonsils because of toxic wry neck. A cultist, after 6 "adjustments" stated that her neck was well, all she needed was the will to use it. He urged disciplinary measures to the extent of corporal punishment to compel her to exercise her neck musculature. Dr. J. Eschenbrenner diagnosed the condition as dislocation of the neck, but the X-ray report was "negative for fracture" and the patient passed out of his control. As a matter of fact, the anteroposterior view through the mouth was discarded because it was poor, so the displacement of the first cervical was not noted. Examination showed typical rotation of the chin toward the right with marked tilting of the head to the left; no rotation toward the left beyond the midline. Palpation of posterior pharyngeal wall showed rotation of the left side of the first anteriorly. X-ray films made at Lutheran Hospital by Dr. E. W. Spinzig revealed severe rotary dislocation of the first cervical vertebra. The left lateral mass of the first had dropped down in front of the body of the second. June 14, 1932, under ether anæsthesia, reduction by Walton maneuver permitted full range of motion to either side. Palpation of posterior pharynx verified reduction; confirmed by X-ray examination after application of plaster cuirass. July 8, 1932, patient had full range of motion. A plaster doll collar was applied and worn for another 3 weeks. She was then given a Thomas collar and allowed to go home, in another town. She returned 10 weeks after reduction with a redislocation, which was again reduced under nitrous oxide gas-oxygen anæsthesia by the Walton technique. She was allowed to come out of the anæsthesia and was seated on a chair for the application of the plaster cuirass. Reduction has remained perfect, 4 months since second replacement.

CASE 40. M. F., man of 26, referred by Dr. H. A. LaForce of Carthage, Missouri, with diagnosis of dislocation of neck. The history was that 12 months previously the patient had suffered a lame muscle in his chest after carrying a heavy load. He went to a cultist in a southern state for treatment. The "doctor" had him lie on his back, relax his muscles, and then violently rotated the patient's head and neck, first to one side and then the other, until a definite click was heard in each maneuver. The patient got off the table with a stiff neck that increased in rigidity during the next days and weeks. He has had variable discomfort and limited motion ever since. Examination revealed the head carried anterior to normal position with strained position of chin. Rotation was practically nil to either side. The head was tilted slightly toward the left and the chin was rotated slightly toward the right. The body of the first cervical vertebra was palpable in the posterior pharynx and was markedly displaced forward. Grip of right hand was impaired. Tactile sense in right hand was below par. X-ray films by Dr. E. W. Spinzig at Lutheran Hospital showed complete forward dislocation of the body of the first cervical vertebra, which carried with it the occiput. Both articular processes had slipped forward until the pedicles of the first cervical were resting on the anterior margin of the body of the second, thus allowing the body of the atlas to lie in front of the body of the axis (Figs. 5, 6, 7). June 28, 1932 just 12 months after the original displacement, patient was given nitrous oxide gas ether anæsthesia by Dr. E. P. Meiners, and reduction was attempted by the Taylor traction method. The body of the first cervical vertebra appeared to be in normal position in the posterior pharynx and rotation of the neck was good. A plaster cuirass was applied. X-ray examination 2 days later showed the dislocation to exist as originally. This probably was a redislocation during application of the cast. July 1, Walton technique was used first on one side and then the other to maneuver the processes back onto their facets. Taylor traction was then applied to bring the

Fig. 8 Plaster cuirass as applied in Case 20. This picture answers many of the objections to plaster for immobilization after reduction of dislocated necks. The patient is obviously comfortable and ambulatory. Comparison with Figure 1 shows that she has been able to eat well and that full correction has been maintained with head and neck in moderate extension.

neck into hyperextension, in which position it was held, under traction, while the plaster cuirass was applied. X-ray through the cast the same day showed complete reposition. Clinical and X-ray examination 16 weeks after reduction show normal position. New doll collar was applied.

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INJURIES OF THE SPINAL CORD AND ITS ROOTS FOLLOWING DISLOCATION OF THE CERVICAL SPINE

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DISLOCATIONS of the cervical vertebræ always damage the structures of the spine, frequently injure the roots of the spinal cord, and sometimes lacerate the cord itself. The dislocation is invariably associated with rupture of the intervertebral disc and of the articular ligaments, and frequently with fracture of the articular processes and crushing of the anterior portions of the vertebral bodies. The direct result of these changes, if the dislocation is not reduced, is a certain amount of deformity and limitation of motion. The injuries to the nerve roots are more serious. The roots may be bruised or even compressed between the dislocated bones, with resulting pain and paralysis. As dislocations are most common in the lower cervical spine, the paralyses of certain muscles of the upper extremities are disabling. Unless the dislocation is reduced, the paralyses may be permanent; and even when normal anatomical relations are promptly restored, maximum recovery may not be attained for many months. Laceration of the spinal cord results in permanent interruption of the involved fibers, because, being upper neurons, they cannot regenerate. But, in addition to the anatomical lesion, there is a further blocking of impulses due to œdema and hæmorrhage in the tissues of the cord. In an early case of partial, or even complete, motor and sensory paralysis, it is impossible to know how much of the paralysis is permanent because it is due to laceration, or how much will clear up when the hæmorrhage and œdema have disappeared. Holmes made clinical and necropsy studies on 50 cases of gunshot wound of the cord, and said: "The prognosis during the first 2 weeks in any one case is extremely difficult, and it must be admitted that there is no one sign or symptom from which we can draw reliable conclusions on the severity of the lesion, or from which we can say, when there is complete motor and sensory paralysis, whether the cord is completely divided or not. It must be remembered that though neither the cells nor the fibers of the spinal cord do regenerate, very considerable improvement may occur, as at least part of the early symptoms are due to œdema, circulatory disturbances, and to incomplete damage. The structural damage is consequently not always parallel to the functional loss."

Surgeons are agreed that operative interference can do nothing for the fibers which are actually lacerated, but they disagree about treatment of the physiological interruption. Some believe that immediate laminectomy should be done. They see definite indication for surgery in the experimental work of Allen, and justification in their clinical results. Allen produced supposedly similar injuries to the spinal cords of animals, and claimed that those animals in which the dura was opened within a few hours made better recoveries than those in which the dura was left intact. Coleman modified the indications for early operation to include only those cases of complete or severe partial interruption of motor and sensory impulses in which spinal puncture and compression of the jugular veins (Queckenstedt's test) demonstrated enough swelling of the cord to cause a block in the circulation of the cerebrospinal fluid. He said that these cases "should have the pressure relieved to conserve such fibers as escaped destruction by the original injury." If Allen's findings are reliable, this is a logical method of selecting cases for operation, and it has been adopted by those who believe in surgical interference.

On the other hand, many surgeons, and especially those of large experience in railroad and mine injuries, believe that laminectomy is rarely, if ever, indicated in these cases. Before the operation was frequently performed, they saw instances of partial or complete recovery from paralysis in the course of a few weeks of conservative treatment. They deduced that these changes were due to absorption of œdema and hæmorrhage, and pathological studies like those of Holmes confirmed this view. On the basis of clinical experience, they refused to accept Allen's conclusions, recognizing the many chances for error in such experiments. They could see no difference in the results in comparable cases treated surgically or conservatively, provided the operation did no damage; and they were convinced that good results following laminectomy would have been the same or better without the operation. Some surgeons gave up laminectomy, especially in injuries of the cervical cord, because of disastrous experiences. Taylor, who has done more than any other to put the treatment of these

Fig. 1. Partial spontaneous reduction of dislocation of fifth cervical vertebra. Case 1.

Fig. 2. Dislocation of fifth cervical vertebra, before reduction. Case 2.

injuries upon a sound basis, states that many years ago he operated in 3 consecutive cases on the first to fourth day after injury; all the patients were in good general condition except for paraplegia; when the dura was divided, the cord fractured, and all patients died within 24 hours.

The following case reports will serve to illustrate some aspects of the injuries to the spine, roots, and cord.

Case 1. A woman, 54 years old, was seen December 22, 1925; referred by Dr. S. H. Hurwitz. Immediately after an automobile accident, December 20, she had marked weakness of the right arm and leg, which increased for several hours. Examination showed a Brown-Séquard paralysis. The right pupil was contracted and did not dilate when shaded. The right deltoid and flexors of the elbow showed about half normal power; and the triceps, the flexors and extensors of the wrist and fingers, and the intrinsic muscles of the hand had no voluntary motion. In the right lower extremity, all motions at the hip and knee, and plantar flexion of the ankle and toes, were carried out with about one-fourth normal strength, and there was no voluntary dorsiflexion of the ankle and toes. There was no motor loss on the left side. Pain and temperature sensation were absent on the left up to and including the seventh cervical segment, while light touch was detected everywhere. There was no superficial anæsthesia on the right side, but sense of position of the toes was diminished. These findings indicated an injury of the right half of the spinal cord at about the sixth cervical segment. There was no deformity of the neck, and only moderate tenderness on pressure over the fifth and sixth cervical spinous processes. X-ray films showed a partial anterior dislocation of fifth cervical vertebra (Fig. 1). The patient was kept at bed rest, with light traction on the neck by means of a Sayre head harness, for 3 weeks. A Thomas collar was then applied. At this time she developed pneumonia and phlebitis of the saphenous veins, so that she was not out of bed until the sixth week. The right arm and hand were treated with heat, massage, and passive motion during her stay in hospital. On the sixth day after the injury the triceps and extensors of the wrist and extensors of the ankle showed slight voluntary motion, and the highest level of sensory loss was at second dorsal segment. On the fifteenth day all muscle groups of the right lower extremity had almost one-half normal power, and the upper level of anæsthesia was at tenth dorsal. She began to walk in the sixth week. When she was dismissed from the hospital, in the fourteenth week, she was walking with a slightly spastic gait; coarse motions could be carried out with the right hand; the right knee jerk and ankle jerk were increased, and plantar stimulation gave a dorsal response on the right; pain and temperature sensation were diminished below tenth dorsal on the left; and the right pupil remained smaller than the left. A year after the accident she reported that she did all of her housework, that she could walk several miles without fatigue, and that she wrote and did fine needlework with her right hand, which was still improving.

In view of the frequency with which the X-ray examination shows a complete dislocation in patients who have no signs of injury to the cord, it must be assumed that the dislocation was much more marked and that partial spontaneous reduction occurred. The patient's progress under conservative treatment showed clearly that only a small portion of the motor and sensory loss was due to actual laceration, and therefore permanent. Of the remainder, that due to œdema and hæmorrhage cleared up in 2 months, but recovery from the root injuries was very slow, and had not reached its maximum a year after the accident. It is possible that recovery of the roots would have been more rapid and complete if the partial dislocation had been reduced.

Fig. 3. Dislocation of fifth cervical vertebra, 10 weeks after reduction. Case 2.

CASE 2. A man, 30 years old, was seen January 7, 1931. He was injured in an automobile accident December 16, 1930, and was admitted to hospital December 22. The X-ray films showed an anterior dislocation of fifth cervical vertebra (Fig. 2). From December 23 to January 7 constant traction had been applied to the head without result, as shown by further X-ray examination. He complained of severe pain in the right arm. There had been a complete paralysis of the right arm and leg, and a partial paralysis of the left arm, but by January 7 some improvement had taken place, and the neurological findings were almost exactly as in Case 1. On the right there was a Horner's syndrome, a "lower arm" type of paralysis, and very marked spastic weakness of the lower extremity, with increased reflexes and positive Babinski. On the left side, there was diminished pain and temperature sensation in the lumbar and sacral distribution. January 9, the dislocation was reduced and the entire spine was immobilized in a plaster dressing. The pain in the right arm stopped at once and did not recur. He was ambulatory from the fourth week after reduction. The plaster was replaced by a Thomas collar in the tenth week. In 5 weeks the strength of the right lower extremity was little below normal, and the grip of the right hand was about one-third of normal. In May, 4 months after reduction, the right lower extremity had normal power, though pyramidal tract signs were still present. The grip of the right hand was three-fourths normal and still improving. Eight months after injury, he reported that he had discarded the collar and returned to manual labor. Figure 3 shows the anatomical condition of the spine ten weeks after reduction, when the plaster dressing was discarded.

In this case, the dislocation was not reduced by constant traction, but was easily reduced by Taylor's method. The root pains ceased as soon as reduction was accomplished. As in the first case, events proved that most of the paralysis was due not to laceration, but to hæmorrhage and œdema of the cord, and to injury of nerve roots. If a laminectomy had been done on this patient, it might have resulted in as good a recovery from the cord injury; but without reduction of the dislocated bones, there would certainly have been a less satisfactory return of function in the involved upper extremity, and the permanent loss due to root injury would probably have been disabling.

Fig. 4. Dislocation of fifth cervical vertebra, before reduction. Case 3.

DIAGNOSIS

The injury to the spine may be suspected from the history of the accident, the position of the head, the patient's disinclination to move the neck because of pain, and the tenderness on palpation; but lateral X-ray films give all necessary information without risk to the patient. The neurological examination pictures accurately the extent of interruption of motor and sensory impulses, but a total functional interruption does not necessarily mean a transsection of the cord, and a complete anatomical interruption cannot be diagnosed for several weeks.

TREATMENT

These cases have been treated, with a few modifications, by the method described by Taylor. To prevent further injury, the patient should be handled with great care while being moved; he should be put on a flat hard bed, without flexing the neck, and the head should be temporarily immobilized with sand bags or with light traction. Lateral X-ray films are made without moving the patient, who remains upon his back on the bed or stretcher. The reduction is then done. Taylor said, "a proper fracture table (e.g., Hawley's) must be available; a good orthopedic associate . . . must be present; and a good, portable X-ray

Fig. 5. The plaster dressing. Dotted line indicates level of wipe joint. Note the dorsal flexion of neck, upward pressure of plaster on mandible and occiput, and downward pressure on shoulders. Case 3.

machine and technician must be ready to take and develop plates to verify the reduction. . . ." The patient is placed upon a Hawley table. A Sayre harness is applied to the patient's head, with attached ropes tied around the operator's waist, so that he can control the patient's head and neck with his hands while applying traction with his body. General anæsthesia is unnecessary and inadvisable. The operator pulls gently against countertraction, in the line of the cervical spine proximal to the dislocation, until the muscles of the neck are relaxed; he then changes the line of pull so that the head drops backward, meantime manipulating the region of the dislocation with both hands. There is usually a snap when the bones go into place, which may be felt by both the patient and the operator. With the neck in as complete extension as is comfortable for the patient, an X-ray film is taken and developed. If the reduction is satisfactory, the associate applies a plaster dressing to the head and to the entire spine, while the operator maintains the position with gentle traction. The plaster should press

Fig. 6. Dislocation of fifth cervical vertebra, 11 months after reduction. Case 3.

upward against the occiput and mandible, and downward against the shoulders. The patient may be ambulatory as soon as the plaster is dry, or when recovery from paralysis allows. Taylor replaces the plaster dressing after 3 or 4 weeks with a spinal brace with jury-mast and cupped arrangement to hold up the chin and occiput; but I have kept the plaster on for 2 or 3 months and then applied a Thomas collar to be worn for 6 or 8 months. For several weeks after reduction, occasional lateral X-ray films should be taken to be sure that there has been no recurrence of the dislocation.

These patients should not be transported farther than to the nearest hospital, even though Taylor's three essentials—a Hawley table, an orthopedic associate, and a portable X-ray machine—may not there be available. The X-ray problem may be solved by doing the reduction in the X-ray room; in fact, if the local doctor's office is equipped with an X-ray machine, it is better in small communities, to reduce these dislocations in the doctor's office, especially if the nearest hospital is at a considerable distance. As to the application of the plaster cast, the general surgeon, who is usually in charge of these cases is sufficiently skillful with plaster, but he is greatly handicapped if a Hawley table is not available for, without it, the application of a plaster from the pelvis to the head, without disturbing the reduction, is most difficult. As a Hawley table has rarely been available in my experience, I have worked out a modified method of applying the plaster as described in the following case.

CASE 3. A man, aged 30 years, was seen September 29, 1930. September 25, he fell a distance of 20 feet striking his head. He had severe pain in the neck, made worse by motion, and numbness and weakness of the left arm. Examination showed slight diminution of sensation in fifth and sixth cervical distribution on the left, and about 50 per cent reduction of the grip of the left hand. The roentgenograms (Fig. 4) showed a dislocation of fifth cervical vertebra. September 30, the reduction of the dislocation was proved to be perfect by X-ray examination before the application of the plaster, which was accomplished with considerable difficulty by pulling the patient up so that the buttocks rested on the table, and depending upon an orderly, crouched under the patient's body, to support the shoulders. Films taken a week later showed that the dislocation had recurred. October 11, the plaster was removed, and the patient was placed face downward with his upper chest and pelvis upon two padded boxes. A plaster dressing was applied from the axillæ downward to include the crests of the ilium. After this had dried, he was turned on his back and the shoulders were brought over the end of the table. I had controlled the position of the head during these procedures, and I now did the reduction. My associate then applied the remainder of the plaster, making a wipe joint with the body cast. After a week the patient was ambulatory. Figure 5 shows the plaster dressing, which was worn for 3 months without discomfort. Occasional X-ray films confirmed maintenance of the reduction. A Thomas collar was worn for 5 months more. Roentgenograms taken 11 months after the second reduction show that anatomical relations remained normal (Fig. 6). As to the root injury, the pains ceased immediately on reduction, and the arm regained normal motor and sensory function in about 6 weeks.

RESULTS

Reduction was attempted in all but 3 of 12 cases. These 3 were: Case 1, in which the position was, perhaps mistakenly, considered satisfactory; and 2 cases without cord injury and with slight and recovering root injuries, seen more than 3 months after injury, with X-ray pictures showing new bone between the dislocated bodies. Of the 9 attempted reductions, 6 were complete, with 5 anatomical results similar to those pictured in Cases 2 and 3. In the sixth case, one of complete anterior dislocation of third cervical vertebra without injury of the cord, normal anatomical relations were restored twice, on the day after injury and again 6 weeks later; but each time the dislocation recurred partially after application of the plaster dressing. The procedure used in Case 3 had not been worked out at that time. The functional result was surprisingly satisfactory, as the root pains disappeared, and motions of the neck were painless and only moderately restricted. In this case the result would not have been so good if the dislocation had been lower, involving the roots to the arms. The two partial reductions were in old cases, 6 and 15 weeks after injury; in each the position of the bones was markedly improved, and both patients regained normal posture and motions of the neck, and one eventually recovered from root injury. One complete failure to reduce occurred in a case of transsection of the cord by dislocation of the fourth cervical, in which gentle traction caused marked disturbance of pulse and respiration; the patient died a few hours later.

Three of the 12 patients died. Of these, 2 survived less than 2 days after injury, and autopsy showed complete transsection of the cord. The third death was not satisfactorily explained. The patient had injury of the roots but not of the cord. The dislocation was reduced 8 days after the accident. Progress was perfectly satisfactory up to the fourth night after reduction, when death suddenly occurred. The coroner's physician reported that the cervical vertebræ were in normal position and that the cervical cord showed no evidence of trauma: he believed that the patient died of heart disease. The results as regards injury of the cord were: 2 deaths, 2 partial recoveries (Cases 1 and 2), and 1 complete recovery. Of the 10 patients who showed signs of injury of the roots, 3 died, 5 made complete recoveries, and 2 made partial recoveries from the root injuries.

CONCLUSIONS

1. Laminectomy can do no good in cases of injury of the cervical cord resulting from dislocation of the spine, and may do harm.

2. Reduction and fixation of the dislocation by Taylor's method offers the best chance for restoration of function in the spine, the nerve roots, and the spinal cord, in so far as the injury to the cord is not due to actual laceration, which is incurable.

3. Transportation of these patients before reduction and fixation is extremely dangerous. I have described modifications of Taylor's method which obviate the necessity of a Hawley table, a portable X-ray machine, and an orthopedic associate, so that proper treatment can be carried out in the nearest hospital or doctor's office in which there is a stationary X-ray machine.

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FRACTURE OF THE FEMORAL NECK

Bilateral Hip Spica Immobilization[1]

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THE Whitman method for the management of fresh fractures of the femoral neck which is based on sound anatomical and physiological principles has been accepted by the medical profession. Normal alinement and accurate apposition of the fractured surfaces can usually be obtained by the Whitman manipulation (traction, internal rotation, and abduction). This procedure is favored in general for the treatment of fractures of the neck of the femur with displacement of fragments. Artificial impaction to produce interpenetration of broken surfaces is advocated by Cotton as a supplement to the Whitman manipulation. The abduction method has three great advantages over any other method —comprehensive mechanical effectiveness, single control, and general availability (Whitman).

The following statements will review for the reader many facts and problems encountered in the care of fractures of the neck of the femur:

1. Fracture of the neck of the femur occurs most frequently in elderly people.

2. The fracture is ordinarily associated with a relatively slight injury.

3. If there is displacement of the fragments the position of deformity of the affected extremity is flexion, adduction, and external rotation.

4. The patient may have none of the classical signs of fracture and little or no immediate functional disability.

5. Impacted fracture of the neck of the femur is uncommon.

6. The danger of life is great, especially in the very aged patients who at the time of the injury are suffering from a cardiovascular renal disease.

7. The mortality rate and incidence of non-union increase rapidly after the age of 60 years.

8. The causes of death are usually (1) shock resulting from the trauma and pain and (2) hypostatic pneumonia.

9. The pain can be entirely alleviated by immobilization of the affected extremity in a plaster-of-paris hip spica.

10. The conservative manual manipulative Whitman-Cotton method of reduction is favored in general.

11. The plaster hip spica which is applied should permit the sitting position which aids in the prevention of hypostatic pneumonia.

12. The incidence of decubitus over the sacral region and lower back depends largely upon the type of plaster spica used and the nursing care during the period of plaster immobilization.

13. Plaster-of-paris hip spica is essential for absolute immobilization of the fractured fragments.

14. Normal alinement and accurate contact of fractured surfaces are prerequisites.

15. Failure of perfect anatomical reduction of the fragments and inadequate immobilization are very likely the two most important factors among the causes of non-union.

16. Continuous, absolute, uninterrupted immobilization with the fractured fragments in normal alinement and firm contact favors the development of bony union.

17. Non-union, aseptic necrosis of the femoral head, absorption of the femoral neck, traumatic arthritis and soft tissue contractures are not uncommon local complications.

18. Traumatic arthritis of the knee is a frequent complication, if, during the manipulative reduction internal rotation is obtained by applying undue force distal to the knee. The position of internal rotation should be accomplished mainly by upward force applied through the operator's fist against the extensor aspect of the greater trochanter.

19. Chronic arthritis may prevent a fractured hip from ever becoming useful.

20. Non-union does not necessarily result in great functional disability.

21. Open reduction with metal or living bone internal fixation should be attempted only by those surgeons who are thoroughly familiar with hip joint anatomy and skilled in the surgical technique used in open reduction of fractures.

The purpose of this report is to present a type of plaster-of-paris hip spica which the writer has used for several years. Also the author wishes to emphasize certain obvious but frequently neglected principles of physical therapy which should be applied during the period of immobilization. The bilateral hip spica (see photograph) offers the following advantages:

1. The plaster cast does not break at the level of the affected hip. The cast may be serviceable for several months.

[1] From the Dayton (Ohio) Clinic, Orthopedic Department.

Fig. 1. Bilateral plaster-of-paris hip spica with four plaster cross bars. Cast does not extend above the crests of the pelvis. Foot segment is in equinus to permit active mobilization of ankle joint through the full ranges of motions. The cast permits the sitting position, minimizes the problem of decubitus, simplifies the nursing care, and remains intact.

2. The nursing care is simplified. The patient may be turned without discomfort by one assistant, and, if necessary, may be transported with ease.

3. Patient may assume sitting position which aids in prevention of hypostatic pneumonia. The cast does not extend above the crests of the pelvis. A cast which encloses the abdomen and lower thoracic region precludes the sitting position.

4. The sacral region and lower back can receive the proper nursing care and the dangers of decubitus are lessened.

5. There is absolute immobilization of the pelvis and affected hip.

6. The integrity of the neuromuscular and articular mechanisms of the ankle and foot of the affected extremity and the knee, foot, and ankle of the unaffected extremity is easily maintained.

Inactivity and disuse of the soft tissues should not be permitted during the several months of immobilization. The surgeon should instruct the patient to contract actively all muscle groups of the lower extremities and the abdominal muscles. The muscle groups of the upper extremities may be kept active by occupational therapy.

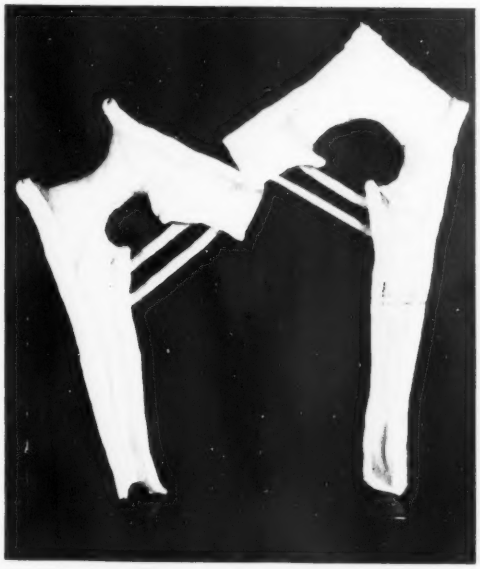

Fig. 2. Bilateral hip spica bivalved, showing the relation of the plaster cross bars to the anterior and posterior halves.

Muscle groups may be actively contracted with or without joint motions. The muscle groups controlling the immobilized hips and knee should be actively contracted frequently each day without joint movements. The muscle groups controlling the ankles, feet, and knee which are not immobilized by the cast should be actively contracted with full ranges of joint motions. Time and patience are essential on the part of the surgeon while instructing the patient and attending nurse until he is certain that the patient can voluntarily actively contract and mobilize the muscle groups and articulations mentioned. Active muscle contractions with or without joint movements is a form of physical therapy which will help to maintain muscle tone and the integrity of the neuromuscular, circulatory, and articular mechanisms. It aids in the prevention of contractures and loss of muscle tone and power, factors which have a definite relation to the final functional result.

FRACTURES IN THE LOWER ONE-THIRD OF BOTH BONES OF THE FOREARM IN CHILDREN

Manipulative Reduction[1]

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FRACTURES in the lower one-third of both bones of the forearm in children constitute a clinical entity as definite as Colles' or Pott's fracture. This fracture is a rather common one in children between 5 and 13 years of age.

In an analysis of 123 fractures treated recently by the writer, it was found that 22 (17.9 per cent) were fractures of both bones of the forearm, 18 (14.6 per cent) of the total being in children, the 4 remaining cases (3.3 per cent) of the total being in adults. Colles' fractures were not included. Of the 22 fractures of the forearm, 14 (63.6 per cent) were in the lower one-third in children. The 4 others (18.1 per cent) of the fractures of both bones of the forearm in children were in the middle one-third. Bagley, in a series of 200 cases found that when both bones were fractured, 90 per cent were in the lower two-thirds. Magnuson also noted that the most frequent site of fracture of the forearm was in the lower third. Grossman reported 500 cases of fractures of the forearm in children ranging from 6 weeks to 13 years of age. Keen, analyzing 38,627 fractures, reported 5.1 per cent in both bones of the forearm. Of 744 cases of fractures of both bones of the forearm, Eliason states that 374 were in the lower one-third.

A study of the literature and standard textbooks on fractures, with few exceptions, discloses no exact technique for reduction of fractures of both bones of the forearm in the lower one-third. Usually such fractures are discussed under general treatment of fractures of both bones of the forearm without reference to any special procedure. The treatment of this type of fracture is as different from that of fractures higher up in both bones of the forearm as is the treatment of fracture of the neck of the femur from that of a fracture in the lower one-third of that bone.

The purpose of this paper is to present a definite manipulative technique used in this series of fractures in the lower one-third of both bones of the forearm. By this method the writer was able to reduce both bones, obtaining normal contour and function in all of the cases.

The *mechanism* concerned in the etiology of this fracture is usually the same as that which in an adult produces a Colles' fracture, namely, a fall on the outstretched hand. Whether such a fall will cause a displacement of the distal epiphysis of the radius or will produce a fracture of one or both bones depends upon the force of the injury and the inclination of the wrist.

Skillern reported 100 cases of fracture of the radius and ulna and found that 13 per cent of them were in the lower one-third, and that the mechanism was gravity with momentum.

A brief review of the *anatomy* helps to explain the mechanism of the forces involved in the etiology, as well as the forces and principles involved in the treatment to be described.

The epiphyses of the radius and ulna unite about the twentieth year. The distal radio-ulnar joint has a trochoid-rotary motion. The distal radio-ulnar and the radiocarpal joints are firmly bound together by a capsule (Fig. 1) which is subdivided into four portions. The *lateral radiocarpal ligament* extends from the tip of the styloid process of the radius to the base of the tuberosity of the navicular bone. The *medial ulnocarpal ligament* extends from the styloid process of the ulna to the triquetrum with some fibers extending to the pisiform bone. The *volar radiocarpal ligament* extends from the volar margin of the distal end of the radius and the base of the styloid process of the ulna, obliquely, distally, and medially to the volar non-articular surfaces of the proximal row of carpals. The fibers from the ulna run obliquely laterally. The deep fibers are closely adherent to the volar border of the articular disc of the distal radio-ulnar articulation. The *dorsal radiocarpal ligament* extends from the dorsal margin of the distal end of the radius in an oblique direction, distally and medially to the dorsal non-articular areas on the proximal row of the carpal bones.

The interosseus membrane of the forearm is a strong fibrous band which stretches across the interval between the radius and ulna. This membrane and the distal radio-ulnar ligament (Fig. 2) assist in the reduction of the fractures to be described.

The pronator quadratus muscle (Fig. 3) on the volar surface of the forearm near the wrist, takes

[1]Read before a joint meeting of the Chicago Roentgen Society and the Chicago Orthopedic Club, October 12, 1932.

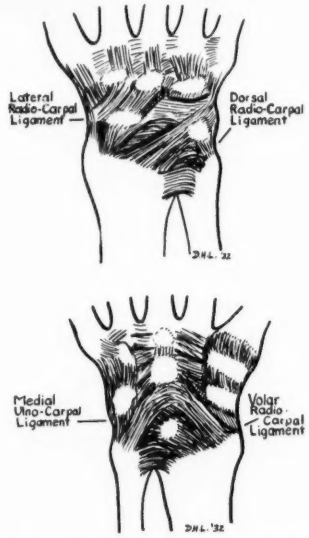


Fig. 1. The ligaments about the wrist.

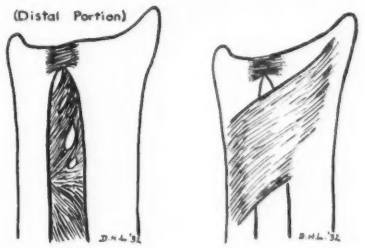
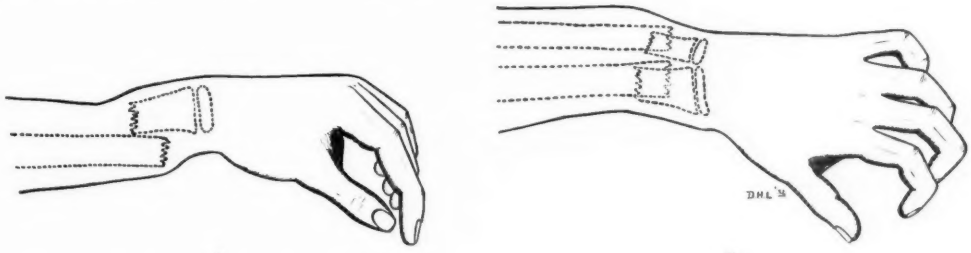


Fig. 2, left. The distal portion of the interosseous membrane of the forearm. Note the direction of the fibers.

Fig. 3. The pronator quadratus muscle. Note the obliquity of the fibers and their attachments. In fractures of the lower one-third of both bones of the forearm, supination stretches the muscle, pulling the distal end of the radial fragment ulnarward.

its origin in the lower one-fourth of the volar surface of the ulna proximal to its neck. The fibers pass *laterally* and *distally* to be inserted into the volar surface of the lower one-fourth of the radius. Anterior to the pronator quadratus lie the radial and ulnar arteries and nerves, the deep veins, and the flexor tendons. In a fracture of the lower one-third of both bones of the forearm, supination stretches the pronator quadratus, pulling the distal radial fragment ulnarward and increasing the overriding as well as the displacement. Supination also stretches the pronator radii teres, pulling the proximal radial fragment anteriorly, that is, volarward, or into pronation.

On *examination*, one finds a silver fork deformity with radial deviation of the hand (Fig. 4). In addition to this deformity which resembles that of a Colles' fracture, there is also ulnar angulation. Unless the fragments are impacted, there is preternatural mobility and crepitus. Usually both distal fragments are posteriorly displaced and overriding. In fractures in the lower end of the radius, the hand can be greatly hyperextended (Maisonneuve's symptom). Frequently, in the very young, the fractures in both bones are greenstick. Often only the ulnar fracture is greenstick while the radial fracture is complete and overriding (Fig. 5). Outlining the styloids of the ulna and radius, one finds that they are approximately level, as compared with normal in which the radial styloid is about one-third of an inch distal to the tip of the ulnar styloid. There is swelling of the wrist, hand, and fingers. Occasionally the radius is compounded. More rarely both bones perforate the skin. The roentgenograms show the position of the fragments which are usually dentated and frequently comminuted. When they are impacted, the angulation is anterior, the distal radial articulation facing posteriorly and distally (Fig. 6).



A. B.

Fig. 4. A, The silver-fork deformity. The dotted lines indicate the displacement of the radius. B, The radial deviation of the hand. The dotted lines indicate the displacement of the fractured bones.

Fig. 5. Case 6. Completely displaced fracture of radius and greenstick fracture of the ulna with angulation. Before and after reduction.

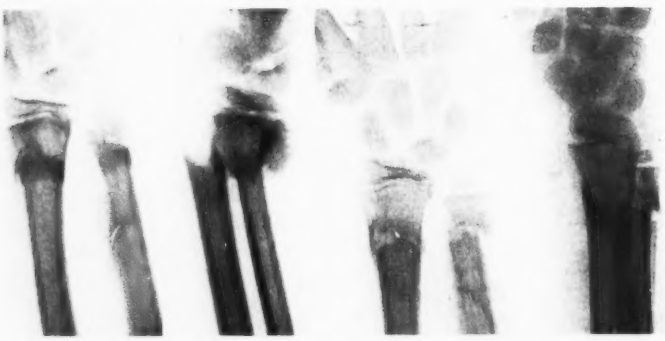


Fig. 6. Case 7. Typical fracture of both bones of the forearm with complete displacement of both bones. Note the anterior angulation of fragments, the distal radial articulation facing posteriorly, the apparent good position in the antero-posterior view, showing need for two views in all cases.

In discussing the treatment of these fractures, Eliason speaks of pronation and reduction but does not describe any specific maneuver. Scudder states that fractures of the radius and ulna should be reduced by strong, even traction, the bones being pressed into position at the same time, and that the forearm should be strongly supinated; and Helfrich, admitting that these fractures deserve special mention, recommends that they be reduced and fixed midway between pronation and supination. Wilson and Cochrane emphasize that "the convexity of the radial shaft permits it to swing across the ulna in pronation without impinging, and that flattening of this curve causes mechanical interference." This crossing occurs obliquely in the upper one-third. While it is an important consideration in fractures in the middle and upper one-third, the question of synostosis due to crossing of the bones is not pertinent in fractures of the lower one-third. Synostosis in simple fractures in the lower one-third must invariably be due to improper reduction. Keen states that "adhesion of the two bones to each other is rare." The writer feels that *complete pronation maintains the necessary radial curve and helps to fix the upper fragments.* This facilitates the reduction of these fractures. DaCosta states that "in fractures of the radius and ulna near the wrist . . . . the upper fragment of the radius is pronated." It has always been a general rule in the treatment of fractures to aline the lower fragment with the proximal one. Any attempt at supination after the fragments have been reduced tends to displace the distal fragments dorsally, angulating them anteriorly. Wilson and Cochrane state that "fracture of both

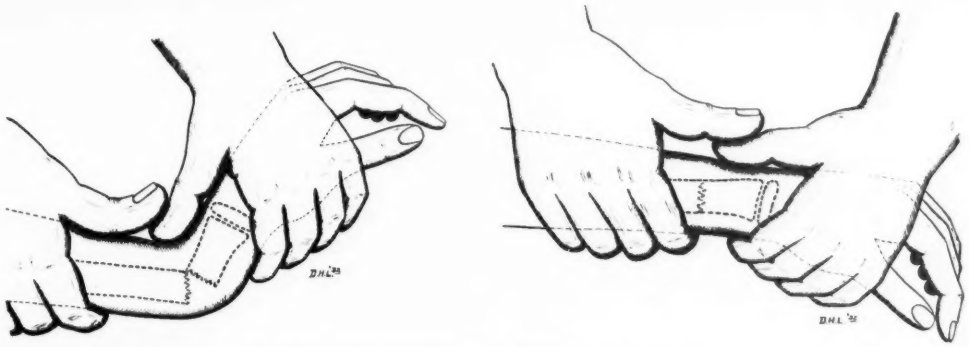


Fig 7. A, left, The maneuver, emphasizing angulation and distal push of the superimposed thumbs of the operator. B, The alinement of the fragments.

bones is one of the most difficult of all fractures to treat, and open reduction is more frequently resorted to than in the case of many other fractures, but closed methods should be given a fair trial."

Santy urges early, almost emergency, operation when there is displacement with fracture of both bones, and states that "every hour wasted on non-surgical measures makes surgical intervention more difficult." Todd reduced these fractures by inserting a metal pry pin. Ghormley and Mroz state that "often the only method of getting satisfactory reduction of these fractures is by open reduction." Grossman does not describe the type of manipulation which he employs, but states that the cast extends from the elbow to the metacarpophalangeal joints. In fractures of both bones of the forearm higher up, he includes the arm and elbow.

Conwell employs a procedure similar to that to be described, but he applies board splints which do not include the arm, and the hand is held mid-

Fig. 8. The cast from midarm to metacarpophalangeal crease, with the forearm completely pronated.

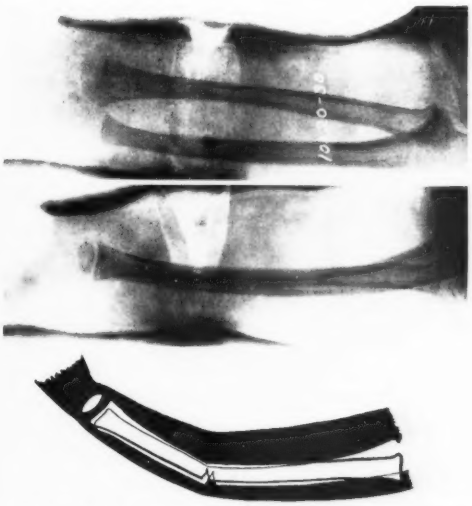


Fig. 9. Case 2. Greenstick fracture of both bones treated by applying cast over the deformity, cutting cast around ¾ of its circumference leaving "hinge" on remaining ¼ and then, under fluoroscopic control, wedging the cast, alining the fragments, and reinforcing the cast in the corrected position.

Fig. 10. Case 3. Fracture November 21, 1930. Reduction 2 days after injury.

Fig. 11. Case 4. Fracture May 15, 1931. Reduced 2 days after injury.

way between pronation and supination. While one of his splints includes the elbow, it cannot as described immobilize that joint and prevent rotatory effort. Clayton prefers mid-pronation, although occasionally supination is found more favorable. Maisonnet recommends external maneuvers, or continuous extension with immobilization, the forearm being in complete supination. In his opinion, if reduction cannot be obtained in this manner, operation becomes necessary. Jopson advises fixing the forearm on a fulcrum such as a triangular block. Shipley discusses open reduction of fractures of the forearm, immobilizing them with the hand in sharp flexion. Discussing this paper, Campbell states that "manual reduction can be obtained in a large percentage of cases by treating both bones as one and angulating. It is impossible to reduce one bone at a time as the other will become displaced again." Ramey also emphasizes immobilization midway between pronation and supination. Boehler reduces these fractures by traction and fixed countertraction in pronation applying a cast without padding from the axilla to the fingers.

The *reduction* should be accomplished as soon as possible after the accident. The anæsthetic of choice for surgical relaxation in the fluoroscopic room is ether. The fact that several days have elapsed since the accident, and the fact that several previous attempts have been made, should not deter the surgeon from attempting this maneuver. In 2 of the writer's cases, 12 and 17 days had elapsed since the occurrence of the fractures, but by the method to be described, the fragments were apposed and satisfactory results were obtained. The reduction should be accomplished in a lighted room on the fluoroscopic table, the operator wearing colored glasses to facilitate

Fig. 12. Case 5. Fracture May 27, 1931. Reduced same day as injury.

Fig. 13. Case 9. Fracture January 9, 1932. Reduced 2 days after injury.

the view of the fragments when the fluoroscope is used. There are two advantages in working in the lighted room, namely, minimizing the exposure of the operator to the roentgen rays, and secondly, permitting him to see exactly what he is doing, thus avoiding unnecessary trauma to the parts being manipulated.

To describe the *technique* of the manipulation, an overriding fracture of both bones of the left forearm will be chosen as an example. The surgeon stands at the left side of the table. The patient lies on the extreme right side of the table so that it is not necessary to move him when a fluoroscopic view is desired. The elbow of the patient is flexed at right angles, and an assistant encircles the arm of the patient with his hands. *During the entire manipulation the forearm of the patient is held in complete pronation.* The operator places his left thumb on the dorsum of the distal radial fragment, his fingers grasping the patient's hand over the thenar eminence. With his right hand he grasps the forearm over the distal end of the proximal radial fragment, the thumb of this hand resting upon his own left thumb. Maintaining pressure with both thumbs on the distal fragment, the operator gently angulates the fragments, increasing the deformity, and at the same time exerting a distal push and some traction (Fig. 7A).

The surgeon must constantly bear in mind the possibility of injuring the important structures lying anterior to the angulated fragments. The

Fig. 14. Case 10. Fracture February 3, 1932. Reduction 12 days after injury.

Fig. 15. Case 12. Fracture April 2, 1932. Reduced 1 day following fracture.

Fig. 16. Case 13. Fracture April 24, 1932. Reduced same day as injury by wedge-cast method.

protection of these structures by the pronator quadratus is of considerable value. Another safety factor is afforded by working in the lighted fluoroscopic room so that the condition of the soft tissues is constantly evident. The distal push by the thumbs is maintained, the traction in the longitudinal axis is increased, and the angulation is gradually decreased, as the fragments skid into apposition. The hand, wrist, and distal fragments are straightened and gradually palmarflexed with moderate ulnar deviation, the thumbs maintaining their pressure on the distal fragments (Fig. 7B). At this time the room is darkened, and the position of the fragments is checked by the fluoroscope. It is usually found that the pull on the radiocarpal ligaments and the pronator quadratus and the distal portion of the interosseous membrane will have reduced the ulnar fragments during the manipulation of the radial fracture. Should the manipulation fail on the first attempt, it should be tried a second and a third time if necessary. When the reduction is complete, a circular cast is applied from the axilla to the palm, with the elbow at a right angle and the forearm in complete pronation (Fig. 8). No stockinette is used. The cast is applied over a moderate amount of sheet wadding, the operator retaining the fragments while an assistant applies the plaster. The writer recognizes the fact that, handed down through the ages there is a dictum condemning circular casts, particularly in the early treatment of fresh fractures. Agreeing that the novice or unskilled must be warned, and that even those experienced in plaster-of-paris technique must be ever watchful of circulatory constriction, I have had no misfortune that would cause me to deviate from my routine application of circular casts in fresh fractures. These retain the reduction with greater certainty, are not disarranged, and cause less circumferential pressure than do bandages and adhesive applied over board or metal splints.

Roentgenograms are taken as soon as the cast is dry. In one case in this series, in which both fractures had been properly reduced, check-up roentgenograms showed excellent radial reduction but there was angulation of the ulnar fragments. Through a window on the ulnar side, this was completely corrected without anæsthesia, and without disturbing the radial fragments. The patient is not dismissed without frequent observation and competent instruction to house physician and nurse, or parents, if patient is sent home.

Finger motion is started early. The cast is bivalved at the end of 10 days to 3 weeks. The position of the fragments is again verified by roentgenograms. In one of the cases of the writer's series, a check-up roentgenogram at the

A. B. C.

Fig. 17. Case 14. A, Roentgenogram taken after original reduction. B, Roentgenogram taken 12 days later, at time first seen by author. C, End-result. Manipulative reduction accomplished 17 days after injury.

end of 10 days showed angulation of the fragments. Upon inquiry it was found that the patient had fallen and, without breaking the cast, had angulated the fragments. Satisfactory readjustment was made and a new cast applied. Had no check-up roentgenograms been taken, this patient would have had a poor result. When the cast is bivalved, heat, passive exercises, and light massage are started.

In younger children, all retentive apparatus is removed at the end of 2 to 3 weeks. In older children, a small portion of the cast representing a posterior mold of the forearm, wrist, and hand is reapplied for protection. In all cases, early supination exercises and mobilization of the wrist and fingers are prescribed.

Greenstick fractures of both bones have been treated by the writer as follows: Anæsthesia is usually unnecessary. A felt pad is applied over the angulation. A snug, circular plaster-of-paris cast is applied from the mid-arm to the metacarpophalangeal crease *without disturbing the fractures*. When it has "set," the dorsum of the cast is cut transversely about one-half inch proximal to the site of the fractures and the distal fragments are gently swung into position as the cast is slowly wedged. The fluoroscope or roentgenogram is used to verify the reduction. A few turns of plaster-of-paris are used to fill in the resultant ellipse and maintain the reduction (Fig. 9).

CONCLUSIONS

1. Fracture of both bones of the forearm in children with overriding is a definite clinical entity and of rather frequent occurrence (14.6 per cent of the writer's series).

2. With a few exceptions, a definite technique of reduction is not described in the literature.

3. Exact knowledge of the anatomy and pathology with a mental picture of the structures involved is essential.

4. A definite manipulative reduction in a lighted fluoroscopic room is described. It consists of pronation with anterior angulation of the fragments, and thumb pressure with traction, followed by gradual alinement and palmar flexion.

5. With the forearm in pronation a circular plaster-of-paris cast is applied from the axilla to the metacarpophalangeal crease.

6. Early function of the fingers, wrist, radioulnar and elbow joints is advised.

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SPINAL ANÆSTHESIA, NERVOUS SYSTEM SEQUELÆ

A CASE IN POINT

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SPINAL anæsthesia with cocaine and its derivatives is commonly used. Various sequelæ affecting the central nervous system are known, but are individually rare. A discussion of them may be of interest to the surgeon and to the physician considering the use of spinal anæsthesia.

The technique of spinal anæsthesia, including the precautions against shock due to the drug used, is standardized. Statistics as to accidents deal chiefly with fatalities from shock, and do not give much information about the sequelæ affecting the central nervous system.

Jones maintains that the diffusion of the anæsthetic, which commonly ascends to the cisterna magna and the base of the brain, is not determined by the concentration or the specific gravity of the solution used. Johnston and Henderson call attention to certain individual anatomical variations in the spinal canal and the dentate ligament and deposits of fat around the spinal cord as perhaps explaining why the diffusion of the anæsthetic varies. The position of the patient does not account for variations. A more complete knowledge of the absorption of drugs from the cerebrospinal fluid would throw light on this problem.

Davis and his coworkers have shown that spinal anæsthetics have a hæmolytic action on blood cells and a myelolytic effect on tissues of the spinal cord, and that there is a meningeal reaction with plasma and lymph cell exudate not due to infection. Also, degenerative changes are found in the grey and white substance. They quote Spielmeyer as finding similar anterior horn changes after anæsthesia of spinal roots. These, however, are not permanent. In animals killed from 30 to 90 days after spinal anæsthesia, fibrotic scarring of the meninges was noticed. Lindemulder describes comparable root, meningeal, and cord reactions in a man dying 12 days after operation.

The fall of blood pressure during spinal anæsthesia is not clearly understood. Jones states that the drug acts on the spinal roots, and not on the spinal cord. Cranmer and Henrikson hold that fall of blood pressure is due to paralysis of white rami, and a consequent paralysis of splanchnic vessel constrictors. Bower and his coworkers regard blood pressure fall as due primarily to cardiac dilatation which will occur when the drug reaches the fourth thoracic segment level, and state that the rate of fall varies with the rate of ascent of the drug in the spinal canal. Ferguson and North state that the rate and degree of blood pressure fall depends on the number of white rami paralyzed. Whatever the mechanism, it is reasonable to believe that an unduly great and rapid fall of blood pressure would predispose to cerebral vascular disturbances.

Blatt states that spinal anæsthesia should not be used in individuals with neuropathic constitution. He does not define what he means by neuropathic constitution, but by implication he refers to persons with poor vasomotor tone, who might be over-reactive to a widespread diffusion of the drug, and the occasional extreme changes in blood pressure and heart action. One can see how the hæmolytic effect of a spinal anæsthetic, observed by Davis et al, might be accentuated in persons with fragile capillaries or unstable vasomotor tone.

Saklad has shown that after spinal anæsthesia alterations in blood chemistry occur much less frequently than after ether anæsthesia. It would seem, therefore, that spinal anæsthesia does not

produce a systemic intoxication. Tabanelli found a diminution of red blood cells and a shift in the proportions of the various types of white blood cells. There was no noticeable change in the hæmoglobin. Coagulation time showed a slight increase lasting a few hours. Bleeding time decreased in some instances and increased in others. In view of his findings, there is no evidence that the drugs used directly predispose to hæmorrhage reactions of systemic nature.

Angelescu and Tzovaru believe that the delay in appearance of certain sequelæ represents an "incubation period," and that infection is responsible.

The complications of spinal anæsthesia affecting the central nervous system, reported in medical literature, may be classed as:

I. *Local or neighborhood*, due either to trauma by the injection of the needle, or to the effect of the drug on nerve roots or nearby spinal cord tissue.

II. *Distant focal*, due to causes not yet determined.

III. *General*, in which the entire central nervous system is evidently affected, with perhaps the major insult limited to certain areas or tissues.

In accordance with this classification, the following clinical conditions have been described.

I. *Local or neighborhood.* These may be divided into (1) cauda equina lesions, (2) conus lesions, (3) myelitis—in the lower segments of the cord, and (4) spinal claudication (Albo and Pla). The cauda equina lesions are radicular in type. Piccardi reports 2 cases of vesicular eruptions on the heels after the use of tutocaine. I have seen 2 cases of unilateral herpetiform lesions in the upper lumbar segment areas following novocain spinal anæsthesia.

II. *Distant focal.* These may be divided into (1) cranial nerve, (2) brain and brain stem, (3) spinal cord.

As to the cranial nerves, primary optic atrophy has been reported by Jacqueau. Extraocular muscle paralyses are the most frequently mentioned sequelæ. They are usually associated at onset with headache, vertigo, and photophobia. The external rectus is most often involved. Adams quotes Cushing as explaining these as caused by swelling of the pons and direct pressure on the nerve trunks. Since these paralyses appear several days after the anæsthesia, and since there seems to be no clinical or autopsy evidence that pons swelling occurs, this hypothesis is open to question. The exposed course of the abducens nerve makes it especially vulnerable to any insult. Pallestrini comments on nystagmus as being a common transient phenomenon. De Courcy cited a case of nystagmus appearing about 10 days after anæsthesia and lasting for several weeks. Involvement of the facial, auditory, and hypoglossal nerves has been mentioned by Angelescu and Tzovaru.

Regarding the brain and brain-stem complications, Arnheim and Mage reported 3 cases of hemiplegia, but one of these can perhaps be discounted because it developed 3 days after operation. Rapoport observed one instance in which sudden death occurred during the operation immediately after the patient elevated his head.

As to spinal cord complications, Bodechtel reported a case of diffuse and ascending hæmorrhagic myelitis. The Brown-Séquard syndrome and various other involvements of the spinal cord have been reported. Brachial nerve involvements have been noted (Tabanelli).

III. *General.* (1) Headache and stiff neck, lasting a few days, are common, and should not be regarded as either complications or sequelæ of spinal anæsthesia. Falk finds that these symptoms occur in 6 per cent of spinal anæsthesia cases. Other writers give varying percentages, but this figure seems to be approximately correct. Occasional instances have been reported in which headache persists for weeks.

(2) Infective meningitis due to accidental infection during injection also should not be regarded as due to the drug used, and in this sense is not a sequela, but rather a complication of infection due to accident. Anderson states that 9 such cases have been reported in 20 years.

(3) Encephalitis has been described by various writers, and the symptoms common are headache, vertigo, photophobia, confusion, hallucinations, and at times extraocular paralysis. Adams mentions one case of stupor lasting 9 days after the anæsthetic.

(4) Aseptic meningitis and meningo-encephalitis have been reported.

According to Frick, if death is to be regarded as caused by spinal anæsthesia, it must occur within 2 hours after administration. Such fatality happens in about 1 in 10,000 cases, according to Frick and Tendler. Rapoport, in a series of 1,875 cases, reported 1 sudden death following change of head position, and 4 other cases of fatality, but believes that the spinal anæsthetic was responsible in only two of the series.

Various writers (5, 11, 16, 20, 23, 25), reporting on a total of 2,074 cases, noticed and described certain central nervous system sequelæ in 11 patients (0.5 per cent).

TABLE I

Date	Blood pressure	Spinal fluid pressure mm. water	Spinal fluid, W.B.C. per c.mm. (90% or more lymphocytes)
June 11 (morning)...	180/100	700	170
June 11 (afternoon)..	160/95	250	Not counted
June 12 (morning)...	180/100	400	840
June 12 (afternoon)..	Not recorded	320	480
June 13.....	156/80	400	180
June 14.....	175/90	250	80
June 17.....	170/85	350	45
June 19.....	Not recorded	250	17
July 5.....	Not recorded	190	8

Fawcett, quoting Reber, stated that extraocular paralysis occurred in 5 of 2,000 cases. Other writers have found it more frequent. Infective meningitis has been reported 9 times in 20 years (3).

Headache, as a transient phenomenon, occurs in about 6 per cent of cases (12, 27).

Published reports of occasional cases of the serious sequelæ do not give any information as to their frequency. I have seen several cases during the past 5 years, and the experience of my colleagues would seem to confirm my opinion that they are not rare.

SUMMARY

1. Certain serious or protracted sequelæ may follow spinal anæsthesia. Trauma by the injecting needle, accidental infection during injection (3), and the effect on tissues of the drugs used will account for some cases. There is no evidence that infection is a factor except in the cases of purulent meningitis. The extraocular paralyses have a good prognosis. The toxic or aseptic meningoencephalitic reactions seem to be benign.

2. There is no conclusive evidence that any one of the various cocaine derivatives used in spinal anæsthesia predisposes to central nervous system sequelæ. Blatt, Fawcett, and Levine show that the ocular paralyses are more apt to occur after stovaine than after novocain. This may be due to the slow excretion of stovaine.

3. The hæmolytic and myelolytic action of the drugs used, as shown by Davis and his coworkers, and the possibility that individual nonanaphylactic idiosyncrasy or hypersusceptibility may predispose to sequelæ, justify the drainage of spinal fluid after operation in order to remove any drug that may not yet be fixed in tissues or otherwise eliminated. Anderson has proposed such drainage as a means of reducing headache reaction.

4. There should be pharmacological investigation of how long the drugs used may remain free in the spinal fluid. Cytological and chemical study of the spinal fluid during a week after operation might throw light on the cause of delayed sequelæ.

CASE REPORT

CASE 1. Mrs. M. F., age 53 years. The patient, an obese woman, who had chronic arthritis, was almost totally deaf, and who had had her menopause at the age of 40, developed an incarcerated left inguinal hernia on June 7, 1932. The same day, operation under spinal anæsthesia was performed. Neocaine, 200 milligrams in 2 cubic centimeters of spinal fluid, was injected in the fourth lumbar interspace, and ephedrine was used before operation. Pre-operative blood pressure was 160/90.

The spinal anæsthesia lasted a little over 2 hours. During the operation systolic blood pressure remained steady between 120 and 130; pulse was slow and regular, and there was no nausea or vomiting.

The postoperative course was normal until 60 hours after the operation, when the patient was noticed to be dull and incontinent. Her blood pressure was 160/90. The next day June 11, after 20 hours of semi-coma during which glucose solution was given intravenously and by clysis, there were the following findings: (1) respiration resembling the Cheyne-Stokes type; (2) blood pressure 180/100; pulse slow and strong, temperature normal; (3) dullness in both lower lobes of the lungs; (4) neck rigidity and hyperæmic optic discs; (5) blood urea normal, blood sugar 149 milligrams per 100 cubic centimeters; (6) spinal fluid showed 170 white blood cells per cubic millimeter, and a pressure of over 700 millimeters of water. Blood count was normal. Six hours later, blood pressure was 160/95, and spinal fluid pressure was 250 millimeters of water. Culture of this spinal fluid specimen was continued over a week, and remained negative. On June 12 the patient was conscious and rational. There was asthmatic respiration with dullness and râles in both bases posteriorly. In the morning, spinal fluid pressure was 400 millimeters of water, and after drawing 15 cubic centimeters, the pressure was reduced to 150 millimeters of water; systolic blood pressure was 180. A spinal puncture in the afternoon showed pressure of 320 millimeters of water, and 480 white blood cells per cubic millimeter of which 90 per cent were lymphocytes. Later in the day the patient again became stuporous. There was slight weakness of the left face and arm, and a right Babinski sign. There were no signs of meningeal irritation, except a slight neck stiffness. Temperature, urine, and blood urea remained normal. On June 13 the patient was improved. Chest X-ray was negative. By June 17 the mental state was normal, and meningeal irritation signs were absent. Table I shows blood pressure and spinal fluid findings, June 11 to July 5. Between June 19 and July 5 the patient had no complaints, and neurological examination on July 2 was negative. Treatment between June 12 and 19 consisted of forcing fluids, irrigating the colon, and draining spinal fluid to reduce pressure.

From June 7 to June 20 pitressin had been used hypodermically, but in decreasing doses after June 14.

This patient developed an aseptic meningoencephalitis with a complicating asthmatic congestion in the lungs—the symptoms appearing 60 hours after spinal anæsthesia and without any ordinary postoperative complication. The marked increase in spinal fluid pressure and the white cell count in which lymphocytes predominated, and

the absence of fever, change in the blood count, or other evidence of infection indicate that the spinal fluid contained an irritating substance.

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PILONIDAL SINUS

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IN the 8 years between 1924 and 1931, inclusive, 119 patients, 94 males and 25 females, with an average age of 25 years, were admitted to the Massachusetts General Hospital for pilonidal sinus. All of them had active sinuses giving symptoms at the time of admission. Some were original sinuses, and some were recurrent, following one or more previous radical operations.

Twelve of these patients did not have radical operations done, but on the remaining 107 patients, 134 radical operations were done by the visiting and resident staff of the hospital. In this study an attempt is made to analyze the results obtained by the prevailing methods of treatment in this series of unselected cases. Comparisons are drawn between the different methods employed and between the original cases and the recurrent cases.

GENERAL STATISTICS

In the 134 operations in the series ether was used 122 times, ethylene 4 times, spinal anæsthesia 3 times, local anæsthesia 3 times, and nitrous oxide gas oxygen twice. In 70 per cent of the operations methylene blue was injected to make the sinus wall visible. In every case an attempt was made to excise all of the diseased tissue.

The chief difference in treatment was the manner of dealing with the wound. Primary closure, either by Lahey's method or some other, was done in 32 cases. In some no drainage whatever was used, and in others a rubber tissue drain was inserted between stitches or at the lower end of the suture line. Those cases in which gauze drainage was used in conjunction with sutures are grouped together under the head of "partial closure." This group includes all those cases in which any skin sutures were taken, but in which part or all of the cavity was packed with gauze. There were 37 cases so treated. In 65 cases the wound was packed wide open with gauze, without any skin sutures whatever.

Before the most important question of recurrence is discussed, some statistics of lesser importance concerning the series as a whole will be given.

1. The postoperative stay in the hospital averaged 10.9 days.

2. As to the time lost from work because of disability following operation, including time in hospital, the average time was 8.7 weeks. Four patients were excluded because their long inactivity was not due to disability but to the loss of their jobs while in the hospital.

3. The time required for the wound to heal, according to the patients' report, averaged 2.7 months. Known and suspected cases of recurrence were not counted in the average.

4. Out patient department visits. Of the 134 cases operated upon in the hospital, 22.4 per cent made no postoperative out patient department visits. The rest averaged 9.7 visits apiece.

5. Regarding residual symptoms, of the entire group known to be free of recurrence, only 61 per cent are free of symptoms after the lapse of from 1 to 8 years from operation.

6. The patients were asked whether they thought their result was excellent, good, fair, or bad. Fifty-seven per cent rated their result excellent or good, and 43 per cent fair or bad.

The distribution of these six factors among the differently treated groups is shown in Table I.

It will be noted that the complications responsible for additional postoperative hospitalization of primary closures are shared by the partial closure group. In both groups, the stage is set for inadequately drained sepsis.

Once the sepsis is given adequate drainage and the patient is out of the hospital, the partial closure group is on a par with the packed open group in the matter of length of disability. The average disability of the primary suture group is shortened by those cases in which primary union occurred.

It would appear from the next comparison that an equal number of patients having primary closure and those having wounds packed open felt they required no further medical care after they left the hospital. This view was taken by an even larger number of patients with partial closures, doubtless due to the fact that their incisions quickly healed to a rather unimpressive sinus which was easy to care for.

Of the patients who did make out patient department visits, one would expect more visits by the group with packed open wounds, especially in view of their shorter stay in the hospital. The comparatively high average of the primary group is caused by those cases of broken down wounds, requiring more prolonged care than any case of open packing or partial closure.

TABLE I.—RESULTS

	Primary closure	Partial closure	Packed open	All combined
Average postoperative stay in hospital	11.6 days	11.7 days	8.3 days	10.9 days
Average time lost from work	8 weeks	9 weeks	9 weeks	8.7 weeks
Percentage of patients who made no out patient department visits	20 per cent	30 per cent	20 per cent	22.4 per cent
Average number of out patient department visits made by each of the other patients	9 visits	9 visits	11 visits	9.7 visits
Average time to heal	2.8 months	2.4 months	2.9 months	2.7 months
Percentage of cured patients with residual symptoms	40 per cent	36 per cent	40 per cent	39 per cent
Percentage of patients who rated their result excellent or good	57 per cent	45 per cent	70 per cent	57 per cent
Fair or poor	43 per cent	55 per cent	30 per cent	43 per cent

Again the same situation is reflected by comparative healing time. Although the shortest healing times are found in the primary closure group, so also are the longest, and the average remains almost the same as in the group who had no closure at all.

It would have been desirable to know the symptoms in each case after a uniform time following operation, but since the time elapsed varies from 1 to 8 years, such a tabulation would demand a higher order of intelligence than can be found in the average hospital patient. The present report represents only the symptoms present at the time the investigation was made, that is, anywhere from 1 to 8 years following operation, so that it cannot be considered a true end-result for the whole series. It can be used in comparing the three treatment groups, however, since the variations in time are equally divided among them.

The fact is inescapable that as many patients with primary closures report residual symptoms as do those with scar tissue wounds. The symptoms in their order of frequency are: (1) tenderness or soreness of scar, all or part of the time; (2) aching of scar after prolonged sitting; (3) itching of scar; (4) irritation of scar, especially in hot weather; (5) occasional sharp pains in scar; (6) numbness of scar. No type of symptom seems to predominate in any one of the three treatment groups.

The patients' rating of their results reflects more than the medical criteria on which we would judge results. For instance, some of the individuals who had the longest hospitalization, convalescence, and disability, and even some who were left with symptoms, rate their result as excellent. This is probably because the nature of the condition and its prognosis were carefully explained to them in advance. Others, who were really unusually lucky, expressed dissatisfaction, probably because they felt they had been mishandled or deceived. The dissatisfaction appears to have been greatest in the group of complete and partial closures, and at a minimum in the packed open group.

The possibility of error is, of course, inherent in all of these figures based on patients' statements, but it is fair to assume that the inaccuracies are evenly distributed, so that for purposes of comparison between groups the figures may be of value.

RECURRENCE

Recurrence is, of course, the ultimate criterion on which success or failure is judged. Table II shows 30 known recurrences in a series of 98 traced radical operations. Whether a higher or lower rate of recurrence prevailed in the untraced fraction might be argued either way. It will be noted on the same table that the lowest rate was obtained by packing open and the highest by partial closure. I believe that the primary closure group might have usurped this latter distinction were it not for the larger proportion of favorable cases it contains.

It is interesting to note that in 15 cases the diagnosis of recurrence was made by out patient department surgeons after failure of the sinus to heal in the following number of months: 5, 5, 3, 12, 2, 4, ?, 2, 5, 2, 11, 2½, 20, and 24. Seven of these patients are untraced, but of the 8 remaining, in all but 1 the wounds are now healed and free of recurrence. The suggestion is that although the recurrences shown in Table II are all based on at least 1 year's observation, it is still possible that some may prove to be cures. Nor can it be denied that some of the apparent cures may still develop late recurrence.

Table III shows the enormous difference in recurrence rate between original cases (that is, cases in which patients have not already had radical operations), and recurrent cases. From these figures it would appear that primary closure in a

TABLE II.—RECURRENCE WITH RESPECT TO METHOD OF TREATMENT

	Recurrence		No recurrence	Untraced	Total traced operations	Total operations
	Cases	Per cent				
Primary suture	10	36	18	4	28	32
Partial closure	12	50	12	13	24	37
Packed open	8	18	38	19	46	65
All combined	30	30	68	36	98	134

TABLE III.—RECURRENCE WITH RESPECT TO TREATMENT AND TYPE OF CASE

	Recurrence				No recurrence		Untraced		Total traced cases	
	Original		Recurrent		Original cases	Recurrent cases	Original cases	Recurrent cases	Original cases	Recurrent cases
	Cases	Per cent	Cases	Per cent						
Primary suture	8	31	2	100	18	0	4	0	26	2
Partial suture	5	31	7	88	11	1	11	2	16	8
Packed open	1	3	7	58	33	5	15	4	34	12
Total results	14	19	16	76					76	22

recurrent case is doomed to failure, and that open packing offers the best chance of cure. This is, in fact, the policy which has been largely followed in the present series. Note also that partial closure gives a higher recurrence rate than does open packing.

REVIEW OF LITERATURE

Etiology. Since Warren's description of pilonidal sinus in 1867 many theories have been advanced as to its etiology. All agree that it is of congenital origin, and most of the theories appear to fall into two main groups. Among the writers who think that it is primarily a malfusion of the neural canal are Mallory, Ewing, Prey, Streeter, Tourneaux and Hermann, and Delafield and Prudden. The other group, including Dulligan, Stone, Bland-Sutton, LeCron, and Stolper, think that it is primarily an invagination of the ectoderm. H. B. Stone suggests that it may be not a defect at all, but an analogue of the preen-gland in birds. Drueck says the sinus is always a blind tract not connecting with other structures. Nevertheless, many cases are described of sinus tracts perforating the sacrum and even communicating with the neural canal (Brams, Martin, Ripley and Thompson, Moise, etc.). Oehlecker's painstaking observations, already quoted by Cattell and Stoller, lead him to believe that the skin of the "sacral bald spot" is pulled in by its attachment to the "caudal filament," which is put under tension by the disparity in rate of growth between the caudal vertebræ and the overlying skin.

Occurrence. Many writers feel that the sacrococcygeal dimple sometimes seen in infants is the forerunner of pilonidal sinus. Some of the figures on its incidence are as follows: Lannelongue, 20 to 25 per cent of children; Markoe and Schley, 33⅓ per cent (89 dimples and 11 fistulæ in 300 consecutive births); Lane, 39 per cent (29 dimples and 4 sinuses in 85 children under 4); LeCron, 20 to 30 per cent of all individuals; Lawson Tait, 23 per cent of women in Birmingham Hospital; Heurtaux, 4 per cent of adults.

Some observers feel that there is a distinctive type of individual in which pilonidal sinus is most prone to occur, characterized by obesity, hairiness, and glandular dysfunction. Morton believes that there is a familial tendency.

Cattell and Stoller report a series of 59 patients composed of 69 per cent males and 31 per cent females. H. B. Stone refers to a series of 61, made up of 84 per cent males and 16 per cent females. The present series of 119 patients contains 80 per cent males and 20 per cent females.

All writers agree that the average age at which symptoms appear is the early twenties.

Prophylactic treatment. There are advocates for the removal of all sacrococcygeal dimples as a prophylactic measure. Ottenheimer says: "If the dimpling is patent enough to admit a probe even a short distance, operation should be advised." Stone strongly urges the excision of "uninflamed and symptomless sinuses" with primary closure, and adds, "it is not meddlesome surgery but sound prophylaxis."

Non-surgical treatment. Maillard reports a case in which cure lasted at least 6 months by treatment with the galvanic current. Crookall describes a method of packing the sinus with dry silver nitrate and advocates it as an office procedure. There is no generally accepted method of treatment, however, except radical excision.

Surgical treatment. A. Choice of time. Many writers feel that the radical operation should never be attempted until abscesses have been drained and sepsis has fully cleared up. Ottenheimer stresses the importance of this, more particularly in cases of primary closure, and Morter puts too early operation at the head of the list of his causes for failure. It is not given equal importance by all writers.

B. Anæsthesia. Opinions differ as to the anæsthetic of choice. General anæsthesia is used by Bookman and Prey; local novocain by Morter, Lane, and Finochietto; and LaRochelle uses a local block anæsthesia of $^1/_{10}$ per cent butyn solution in conjunction with sodium amytol. Prey makes a point of avoiding local infiltration as he feels it spreads infection through the wound tissues.

C. Skin preparation. Though many writers stress the importance of the sepsis factor, few mention their technique for preparing the skin. LaRochelle uses repeated scrubs with a 1:5000 solution of metaphen.

D. Injection of sinus. Most writers feel that the sinus should be injected with dye in order to define the diseased area. Methylene blue is generally used. Babcock advocates the use of a strong ethereal solution of methylene blue. Dulligan advises methylene blue or paraffin. Bookman believes that the technique of injection is important, and describes it in detail. The sinus is first emptied of secretion by pressure over the sacrum. The point of the syringe is then tied into the orifice with a purse-string suture placed in the skin. Five per cent methylene blue is injected under gradually increasing pressure, aided by massage over the entire region.

E. Excision. LaRochelle uses an elliptical incision at least ½ inch outside of tract, down to the sacral aponeurosis. Dulligan simply says, "elliptical incision down to fascia of sacrum and coccyx." Morter removes the tissue *en bloc* down to the sacrococcygeal fascia. Martin reports a case of sinus penetrating the sacrum and necessitating removal of coccyx and lower part of sacrum. He also urges that the incision be "equilateral" to avoid "lipping" in the healed scar. Ottenheimer removes any fascia that is stained by the dye. Prey has his assistant examine the specimen for dye while he examines the wound. Finochietto believes that ordinarily it is enough to carry the incision to the plane of the sacrococcygeal fascia, but that this must be carefully scrutinized, and if the tract penetrates it, this tract must be followed into the bone. As for the lateral extent of the excision, some writers seem to be guided largely by the appearance of the dye, while others arbitrarily go out to the origin of the gluteus muscles.

F. Closure. It is assumed that when sacrococcygeal dimples are excised the wound should be closed by primary suture. In the case of fully developed sinuses, however, the question is not so simple. To be successful, primary suture has many inherent difficulties to overcome, and several very ingenious schemes have been devised by its advocates.

Lahey's method is to swing a heavy flap into the cavity from one side, leaving the flap attached at both ends, and packing or suturing the resultant lateral defect. His contention is that a resilient scar is better over a bony weight-bearing surface than a rigid, scar tissue one.

Colp uses primary closure without drainage by a method of heavy undercutting and the introduction of strong mattress sutures from the sides reaching across the midline of the fascia. These are tied over a roll of gauze and left in place 8 days if the temperature stays normal. "The majority remain cured."

Prey advocates primary suture provided perfect hæmostasis can be obtained by means of ties and hot packs.

Finochietto uses primary suture, and states that "primary healing is a proof of complete extirpation and recurrence does not take place in wounds that healed by first intention."

Stone advocates primary suture in clean cases and packing open in doubtful ones.

Ottenheimer places stay sutures under the fascia, closes the fat with multiple layers of catgut stitches, and brings a rubber drain out the upper angle of the wound. He suggests the feasibility of filling the cavity with "two butterfly wings of gluteus muscle," to furnish a resilient base for the scar.

LaRochelle and Morter describe methods of partial primary closure which they have found successful. LaRochelle closes the skin tight with no attempt to eradicate any dead space. He then cuts two "eyes" near the center of a 12 inch piece of ⅜ inch rubber tubing, which he carries across the subcutaneous cavity through two tight fitting lateral stab wounds. This is left in place for 5 to 7 days, during which time it is used for hourly

irrigations of 1:5000 metaphen. The wound then "will be healed in another week or two."

Morter places S. W. G. stay sutures under the fascia, packs the cavity with 3 per cent mercurochrome gauze, closes the skin with interrupted silk, and ties the stay sutures over the dressing. After 24 hours, the stay sutures, dressing, and packing are removed, and bidaily Dakin's irrigations are carried out for 3 days. After that dry dressings are used. "Eighty-five per cent heal without infection."

Eisberg reports a series of 19 cases in which primary union never followed primary suture, while the packed open cases healed quicker than those that were sutured either in part or entirely.

Dulligan also advises packing the wound open.

Lane packs the wound open with iodized gauze.

Bookman packs the cavity in layers so that the superficial ones can be extruded or removed and the deep ones left in.

Babcock suggests that time may often be saved by a secondary suture.

G. Postoperative care. Ottenheimer believes that the location of the wound is unfavorable for healing because, "first, it is so situated that it can be constantly subjected to pressure and irritation either walking, sitting, or lying; and second, its proximity to the rectum makes it readily accessible to contamination from the colon bacillus." He accordingly suggests the following regimen: (1) castor oil the night before operation, and high cleansing enema the morning of operation; (2) liquid diet and deodorized tincture of opium, so the bowels are not allowed to move for at least 6 days after operation; (3) patient lies prone or on side for at least 14 days after operation.

H. Healing time and recurrence. There is a dearth of accurate figures on this subject but general impressions are freely recorded.

In 1912 Griffin and Archibald reported a series of 20 cases from the Mayo Clinic with an average healing time of 8½ weeks—15 remained healed, 4 refused further operation, and 1 was reoperated upon 3 times without a cure. This would make a recurrence rate of 30 per cent. Masson's later report on 81 cases gives no figures about results.

Cattell and Stoller report a series of 59 patients from the Lahey Clinic of which 40 were traced. There were 9 recurrences, a rate of 44 per cent. Of the 9 who had the flap closure, 2 recurred. They conclude that the flap method of closure reduces recurrences and healing time.

In Eisberg's series of 19 cases, 5 weeks was the shortest healing time and 24 months the longest.

Dulligan gives 3 to 4 weeks as the healing time in cases packed open.

Saphir says it takes 6 to 8 weeks to heal by granulation.

I. Residual symptoms. There is practically nothing in the literature about this. Lahey feels that a scar tissue covering for a weight bearing surface is a frequent cause of pain and discomfort on sitting.

J. Causes of failure. Most writers imply that the chief causes of failure are sepsis, incomplete extirpation, and dead space. Prey tabulates the factors which cause failure of primary union after complete suture: (1) tension, (2) incomplete excision, (3) local anæsthesia spreading infection, (4) dead space, (5) poor hæmostasis, and (6) operation too soon after acute infection.

Ottenheimer tabulates 8 causes for delayed healing or recurrence: (1) Type of patient who has pilonidal sinus, (2) ill-chosen time of operation, (3) unavoidably unfavorable location of wound, (4) imperfect hæmostasis, (5) incomplete excision of sinus tract and its branches, (6) faulty obliteration of dead space, (7) delayed spontaneous formation of dead space, and (8) failure to remove infected sacrococcygeal fascia. He says also, "What we consider a recurrence is often not a recurrence of the sinus itself, but an infected dead space of fascia or fat, which eventually breaks through the skin and forms a sinus for itself."

Morter states: "clots in the wound assure 100 per cent failure," and gives 3 other causes of failure: (1) too early operation after acute infection, (2) contamination by cutting into sinus, (3) operation during active infection.

LaRochelle believes that an essential part of his method is keeping the clots washed out by hourly irrigations.

TENTATIVE PLAN FOR TREATMENT OF PILONIDAL SINUS

1. Further observations should be collected as to how often pilonidal sinuses develop in sacrococcygeal dimples. The presence or absence of dimples should be noted on each patient's physical sheet, especially in children, so that readmissions for pilonidal sinus may be checked on this point.

2. No radical operation should be attempted until all acute inflammation has completely subsided.

3. The prognosis and plan of treatment should be explained to each patient before treatment is begun, in order to insure co-operation.

4. A careful 2-day skin preparation should be carried out in conjunction with Ottenheimer's scheme of emptying and clearing out the lower bowel.

5. Infiltration anæsthesia should probably not be used if there is any hope of doing a primary suture. It is hard to see how it could fail to spread infection, since some infection is probably always present. It was used in only 3 of our cases, none of them primary closures. One was in the hospital for a month, one made 29 out patient department visits, and the third did well.

6. The sinus tract should be injected by Bookman's technique of securing the syringe point by a pursestring suture. A specially shaped lock-syringe adapter should be used. The ethereal solution of methylene blue used by Babcock must be more effective in penetrating the fine branches of the sinus than a water solution. It should be borne in mind that unless the sinus is *really* injected, the use of dye serves only to induce a false sense of security. In over half of the recurrences in our series, the surgeon's note states that since no dye-stained tissue was left behind he assumed the entire tract was removed. Although an efficient injection would be of real value, we still have no assurance that every branch sinus communicates with the main stem, so that the absence of dye can never be taken as proof of complete extirpation.

The injection of lipiodol as described by Brams is available in selected cases. It was of no help in the one case in our series in which it was used. Paraffin has not been used by us, so no conclusions can be drawn.

7. The excision *en bloc* should expose the entire sacral fascia as widely as the origin of the gluteus muscles. Any suspected area of fascia should be excised. Any suspected area of bone should be destroyed by electrocoagulation and curetting. It might be well in certain notorious cases of repeated recurrence to try the effect of concentrated X-ray treatment in the open wound. A case in point is the following.

Number 251327, 36, male had a radical excision with partial closure, at the Massachusetts General Hospital. Sinus still persisted after 6 months, when second radical excision was done, followed by primary closure. Four years later there was still a persistent sinus, and a third radical excision was done, again with primary closure. The sinus persisted for 11 months, when a fourth radical excision was done and the wound partially closed. After 2 years and 4 months, the sinus still persisted, so a fifth radical operation was done and the wound was packed wide open. Healing took place in 6 months, and there was no recurrence 7 years after the last operation. The operator was a member of the visiting staff on each occasion.

8. Primary closure, by any of the techniques described, should never be attempted in recurrent cases. In original cases it should be attempted only when all of the following conditions can be met: (1) absence of sepsis, (2) perfect hæmostasis, (3) satisfactory extirpation of sinus. Even so, it must be remembered that failure (i.e. delayed healing or recurrence or both) may result from any of the following causes: (1) tension on sutures, and (2) faulty obliteration of dead space, or delayed spontaneous development of dead space. Since success brings a great reduction in the time of disability, the hospital time should be enough prolonged to allow a careful postoperative regimen as suggested by Ottenheimer.

If successful, primary closure offers the shortest period of disability and perhaps the most satisfactory scar. If unsuccessful, the period of disability is greater than average with a maximum chance of recurrence. It should be undertaken only as a considered risk.

Partial closure of the wound, unless done by the methods of LaRochelle or Morter, often is an admission of weak judgment. It is likely that those cases who do well could have had a primary closure, and those who do badly should have been packed open. Partial closure, as usually done, is open to the objection of leaving bottle-necked dead space which cannot granulate from the bottom to the surface. In our series, the disability was long and the symptom and recurrence rate high, out of all proportion to any possible benefit to be gained.

If the wound cannot be closed with at least an 80 per cent chance of safety, it should be packed wide open. Whether plain gauze, iodized gauze or mercurochrome gauze should be used, remains to be determined. The out patient department or home management of the granulating wound should be simplified and standardized.

PILONIDAL SINUS REGIMEN

Based on the data given, the following provisional regimen has been put into effect at the Massachusetts General Hospital. A report will be made on the results so obtained when a sufficient series of cases is collected.

1. *Co-operation of patient.* The condition and treatment must be explained to patient on admission to ensure co-operation during treatment and return in the event of recurrence.

2. *Choice of operation.* Radical operation should be done on clean cases. In abscess cases the abscess should be incised and drained and the patient followed by out patient department or local doctor until acute sepsis subsides.

3. *Pre-operative orders for radical operation:* (a) 2 day skin preparation; (b) castor oil day before operation; (c) cleansing enema morning of operation.

4. *Anæsthesia.* General anæsthesia should be used unless it is specifically contra-indicated.

5. *Scott's solution* should be used in operating room.

6. *Injection.* Sinus should be injected with ether solution of methylene blue. The syringe should be secured with a pursestring suture to prevent backflow. Injection should be made under maximum pressure and the sacral region should be massaged during injection.

7. *Excision.* A symmetrical block excision is done down to the sacral fascia and laterally to the origin of the gluteus muscles. The blue stain should be followed wherever it goes and widely excised. If it enters the sacrum the tract should be uncovered with rongeurs.

8. *Closure.* Closure may be (A) primary, (B) partial, or (C) wide open. Primary closure is to be attempted only in the presence of the following conditions: (a) if the case is original; (b) if no gross sepsis or contamination is present; (c) if satisfactory extirpation of the sinus tissue has been done; and (d) if hæmostasis is perfect.

A. Rules for primary closure are: Any of the plastic methods may be used. All undercutting must be done at full depth of fat layer. All dead space must be obliterated. Delayed formation of dead space must be prevented by mobilizing tissue to a degree that will allow stitches to be tied without undue tension. If a drain is used, it should never be left projecting from the lower end of the wound. It should be brought out at the upper end or between the stitches.

B. Partial closure is not to be used in this series. Any cavity that cannot be obliterated by total closure must be "saucerized." Bottle necked cavities lead to 100 per cent delayed healing.

C. Wide open packing with iodoform gauze will be used. (a) in all recurrent cases and (b) in all cases not qualifying for primary plastic closure. One or two sutures at the lower end may be desirable if the anus has been approached too closely. This will not be considered "partial closure" since it creates no dead space.

9. *Postoperative orders.* (A) In the primary closure cases (a) the patient should lie prone or on side at least 8 days; (b) he should be given liquid diet and deodorized tincture of opium to keep the bowels closed for 6 days; (c) patient should be kept in bed as long as there is any suspicion of sepsis; (d) frankly septic wounds should be given adequate drainage with or without Dakin's irrigations.

B. In packed open cases (a) patient is to lie prone or on side for 4 days; (b) the bowels are to be kept closed for 4 days; (c) packing should be changed after 4 days, after which packing should be changed daily.

10. *Convalescence.* The primary closure patient should be kept in bed between 8 and 14 days. The open wound patient should be kept in bed 4 to 10 days. The latter patient should be discharged to out patient department or to local doctor with instructions for daily packing for one week (district nurse wherever possible) and weekly out patient department visits for observation.

11. *Out patient department care.* The wound must be kept packed to prevent formation of dead space. Secondary sinuses should be curetted, saucerized, and kept packed.

Recurrence cannot be diagnosed for at least 6 months, and apparent recurrences have healed permanently after 24 months. Delayed healing is the result of the development of a secondary dead space. Only incomplete extirpation of pilonidal tissue leads to true recurrence.

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CORRESPONDENCE.

BECK-JIANU GASTROSTOMY

To the Editor: In the July issue of Surgery, Gynecology and Obstetrics I presented an improved technique and the indications for a gastrostomy, fashioned from a plastic flap of the greater curvature of the stomach. This operation has generally been known as the Jianu gastrostomy, after the Roumanian surgeon who did this procedure on dogs and published a report in the *Deutsche Zeitschrift fuer Chirurgie*, 1912, vol. cxviii, pages 383–391. Dr. William C. Beck has recently called my attention to the fact that his father, Dr. Carl Beck of Chicago, while working with his associate Dr. Alexis Carrel in 1904, developed a gastrostomy which utilized a tube made from the greater curvature of the stomach. This experimental work on dogs was presented by Dr. Beck and Dr. Carrel before the Chicago Medical Society and was published in the proceedings of this society in the *Illinois Medical Journal*, new series, 1905, vol. vii, page 463. In the later article written by Dr. Jianu, no reference was made to the priority of the American surgeons. I have recently read the original description by Dr. Beck and Dr. Carrel and there remains no doubt in my mind that the credit rightly belongs to these authors. If an eponym is to be used, it should be referred to as the Beck gastrostomy rather than the Jianu gastrostomy. My failure to note this priority can be attributed to the general employment of the term "Jianu gastrostomy" and to the fact that the article on "a prethoracic œsophagus" by Dr. Beck and Dr. Carrel was listed in the *Index Medicus* under "Surgery of the Neck" and not under "Gastrostomy."

George T. Pack.

EDITORIALS

SURGERY, GYNECOLOGY AND OBSTETRICS

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DECEMBER, 1933

OBSTETRICS AND GYNECOLOGY

THE appearance of the third and concluding volume and the separate index of *Obstetrics and Gynecology*, edited by Arthur H. Curtis, and published by W. B. Saunders Company, marks an important epoch in the medical literature of the United States.

For many years past, important publications devoted to a consideration of this combined specialty have appeared in the foreign literature, notably that of Germany. There are many handbooks available in that language, which are monumental in character. There are practically no comprehensive presentations of this combined specialty published in the English language. There are and have been many excellent textbooks of obstetrics or diseases of women. There are a series of monographs dealing with the varying subject matter pertaining to obstetrics and/or gynecology.

Dr. Curtis has brought together in these three volumes contributions which cover, in a correlated manner, the present day knowledge in these fields. This is an enormous task in itself, but of even greater significance is the fact that he has been able to secure the earnest co-operation of many leaders, who have been willing to contribute their efforts, time, and knowledge to the compilation of these volumes. They present to the students of medicine a systematically edited work on this branch of medical practice.

In such a publication it is not possible to have all the chapters by the various authors of equal merit or originality, nor is a uniform style possible. Nevertheless, it is of great interest and value to the readers to be able to secure intimate contact with various leaders who have written concerning subject matter which is of particular interest to them.

The main purpose of this work is presented in the opening chapter, where it is written that it is the author's idea to present a comprehensive story of "what America has to tell about obstetrics and diseases of women," and to portray the knowledge in the pertinent aspects of anatomy, physiology, preventive medicine, diagnosis, personal management, surgical and non-surgical treatment, technique, and follow-up.

This work may be regarded as a permanent contribution to medical literature, as plans are made for periodic revisions as the progress of knowledge requires new presentations. It is refreshing to contemplate that these volumes are committed to the idea that "obstetrics and gynecology are more than mere branches of surgery," that obstetrics and gynecology are highly specialized fields which are most closely related, and that the carrying out of the reproductive function in woman cannot be separated logically from the mor-

phology, physiology, and pathology of the sex and other closely related organs and structures.

The content of these volumes makes it perfectly clear that the scope of knowledge required of the obstetrician and gynecologist takes him far from the field of a surgical specialist. It becomes perfectly apparent, even to the reader of the table of contents, that surgical treatment, while of a specialized type in both obstetrics and gynecology, assumes the lesser rôle.

Aside from the great importance of this outstanding American treatise, devoted to the combined specialty of obstetrics and gynecology, one should not miss the significance that it is helping to fix, in medical education and practice, the growing trend toward the logical combination of these two separate branches in the medical institutions of this country.

The editor deserves great praise in securing the co-operation of so many leaders, and in correlating their efforts in the production of the volumes of *Obstetrics and Gynecology*, to the advancement of which specialty his life has been devoted. FRED L. ADAIR.

ARTHRODESIS IN JOINT TUBERCULOSIS

AT the July meeting of the International Orthopædic Society in London, the treatment of tuberculosis of the hip was discussed in a symposium, and the same subject was brought up for discussion the following week at the meeting of the British Medical Association in Dublin, when the "Rôle of the Fusion Operation in Surgery of the Hip Joint", was considered. As a result of these discussions, it was very apparent that there should be no sharp distinction between a so called conservative line of treatment on the one hand and a radical or surgical line of treatment on the other.

In recent years, in the United States, arthrodesis in the treatment of tuberculosis of certain joints, particularly of the knee, hip, shoulder and ankle, and by indirect attack, of the spine, has gained in favor. The chief reasons for this are, first, uncertainty concerning maintenance of the so called arrest of the disease following apparently successful non-operative treatment and, second, the length of time necessary to carrying out of the treatment. There has always been a tendency to avoid definitely recording that the disease has been cured.

Tuberculosis of a joint is a secondary focus, the infecting organism coming by way of the blood stream from a primary lesion situated elsewhere in the body. Many patients with tuberculous joints are found to have other demonstrable lesions in the lungs, kidneys, or genital tract, although the lesion in the joint may be the most disabling, and may be that which forces the patient to seek relief. The treatment of such a joint is therefore a measure directed against a local lesion that perhaps is only one of several foci. All observers are agreed that bony ankylosis in suitable position for function is a happy result in tuberculosis of joints. It is immaterial whether the fusion occurs through natural processes or through surgical intervention.

In the British Isles recumbency has long been recognized as a prime requisite in carrying out conservative treatment of tuberculous joints by rest and fixation, whereas in the United States prolonged recumbency has not been looked on as being essential, nor, in the United States in general, are the facilities available, particularly for adult sufferers, for maintaining it. Ambulatory treatment, with the best possible fixation by aid of splints or plaster-of-paris casts, has been generally used

in this country. It is a fair criticism, also, that even with what might be considered ideal facilities and surroundings at command, conservative measures are carried out only too often in a dilatory and haphazard manner. Constant supervision is necessary, and the fact that such supervision is so difficult to give is one of the best arguments in favor of production of speedy fusion by surgical intervention. There is ample evidence that fusion of the knee, hip, shoulder, or ankle can be produced surgically with satisfactory uniformity.

Those who favor conservative treatment pay little or no attention to the long period of time necessary to attain a successful result, nor do they appreciate the frequency with which conservative measures are applied in a haphazard manner. Patients who, after years of treatment in an institution, finally have obtained ankylosis by natural processes, are pointed to with pride. Although the advocates of conservative treatment readily acknowledge that fusion is quickly accomplished by operation, they refer critically to the sinuses that may follow arthrodesis, and to the occasional case in which the disease is disseminated to the meninges. They fail to remember that the same complications are seen in a certain percentage of cases in which conservative treatment is used. They focus their attention, not, as they should, on whether or not the disease in the joint was eliminated by arthrodesis, but on how long the patient lived. Arthrodesis of a tuberculous joint could have no effect on longevity, except in so far as it might favorably influence the patient's resistance by removing one of his tuberculous foci.

If the operative mortality were high, or if postoperative complications, such as dissemination of the disease or prolonged drainage, were usual sequences, it might be argued correctly that the operation was too dangerous. Carefully prepared statistics show that the surgical mortality, if the operation is performed by a competent surgeon, is negligible, that the large majority of wounds heal by primary intention, and that few postoperative sinuses drain unduly long. There is no reason for such operations being undertaken by surgeons not trained and skilled in the handling of such cases, for comparatively speaking the cases are few, and can be cared for at a time and place selected by those competent to carry out such operations. Groups of patients treated by conservative measures, and groups treated by operation, never have been fairly compared. To make such comparison would be difficult, for the patients should be of comparable age, and should have comparable involvement, not only with relation to the joint affected but also with relation to the number and type of tuberculous foci. The truth is that arthrodesis is only a single procedure in the care of these patients.

Arthrodesis is undertaken to obliterate a local condition in any given joint, and the obliteration should be thorough. It is an incident in the treatment of a systemic disease, and its usefulness depends on whether or not it eradicates the disease in the particular joint attacked. The late Sir Robert Jones stated that tuberculosis of a joint should be, when possible, treated as a local malignant growth. There is too great a tendency to split the treatment of tuberculosis of the joints into the so called conservative and radical (operative) measures. As a matter of fact, operative treatment may be the more conservative type, because in selected cases it hastens healing and allows the patient to return to productive life in a much shorter time than would be possible under the regimen of recumbency, rest, fixation of the joint,

heliotherapy, and so forth. Arthrodesis is not applicable in all cases; multiple foci accompanied by poor general condition of the patient, draining sinuses with or without amyloid disease, and involvement of both kidneys are contra-indications. Old people and young children are generally thought not to be good subjects for arthrodesis. Probably the operation is not used often enough in treatment of children, especially if the disease is characterized by much destruction of the surfaces of the joint. M. S. HENDERSON.

EARLY AMERICAN MEDICAL SCHOOLS

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THE conception and the founding of a medical school in New Orleans, which is now the Medical Department of Tulane University of Louisiana, was largely the result of the efforts of two young physicians, Thomas Hunt and Warren Stone, whose original acquaintance was largely one of accident. It is also rather unusual that these two men whose previous training had been entirely different should be responsible for the development of one of the greatest medical institutions in the United States. Thomas Hunt was born in 1808 of wealthy parents. After graduating from the University of Pennsylvania he secured additional training in Paris before returning to Charleston. Warren Stone, also born in 1808, was the son of a Vermont farmer and had none of the advantages as regards education, which Hunt had. He graduated from the Medical School of Pittsfield, Massachusetts, and began practice in Troy, New York. While there, early in his practice, he was called upon to treat the first case of cholera in the city, which occurred in a French immigrant. He became very much interested in the condition, which undoubtedly had much to do with his subsequent career. Shortly after this he left New York en route to New Orleans on the ship Amelia together with one hundred and seven other passengers. There were four cases of cholera on board when the ship left New York, which number after 4 days increased to twenty-five. During a severe storm the vessel was grounded on Folley Island near Charleston, and it was here that Hunt and Stone met, the former being placed in charge of the camp on the island. Following the incident on Folley Island Stone continued to New Orleans, arriving there in December, 1833, and was soon appointed on the Charity Hospital Staff. Hunt, because of his acquaintance with Stone, soon afterward moved to New Orleans and was appointed house surgeon to the new Charity Hospital in New Orleans, which position he held until he resigned in 1834 to devote his entire time to the founding of a medical school of which he, Stone, and Harrison, Hunt's successor at Charity Hospital, had dreamed. Through Hunt's influence, Stone was appointed assistant house surgeon under Dr. John H. Harrison. He, however, performed the teaching duties of Harrison who, because of ill health, was unable to carry on an active teaching schedule even for the first year.

These three men were responsible for the conception and founding of the first medical school in the South and Southwest. On September 29, 1834, the following partial prospectus of the Medical College of Louisiana appeared in the *New Orleans Bee:*

> The undersigned practitioners of New Orleans, convinced of the want of scientific medical knowledge in the state and in several of the adjoining states, and of the non-existence of schools necessary for the diffusion of that knowledge, and aware too that acquaintance with the peculiar diseases which prevail in this part of the union cannot be made in Cincinnati and Philadelphia, but must be obtained by students at the bedside of the patient, and anxious to advance the cause of science and to disseminate the knowledge of human suffering and to put an end to the murderous practice and empirical arts of selfish speculators on the ignorance of vulgar credulity, and thereby to increase the happiness and prosperity of the country, have associated themselves together as a Faculty for the purpose of delivering Medical Lectures in the city under the name and style of the Medical College of Louisiana.
>
> In selecting New Orleans as the place for the location of their school the undersigned have been governed by the following among other reasons:
>
> 1st. Because it is the largest and most populous town in the Southwest and most accessible to students.
> 2nd. Because its hospitals which will be open to the undersigned for the purpose of instruction are the largest in the Southern and Western states, so that Practical Medicine and Surgery can be taught at the bedside of the patient, the only place for this study.
> 3rd. Because the study of anatomy can be prosecuted with more advantages and at a cheaper rate here than in other cities of the United States.
> 4th. Because New Orleans is so healthy during eight months in the year that students can remain in it and study different types of diseases at different seasons.[1]

[1]For the benefit of our northern colleagues who are not familiar with New Orleans today, it should be emphasized that the eight months should be extended to the entire year.

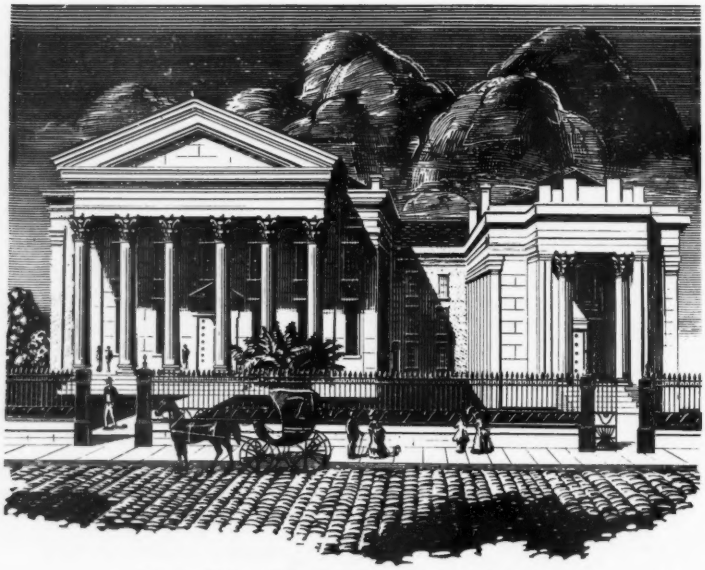

Fig. 1. Tulane University School of Medicine, 1834.

5th. Because it is a commercial town and more surgical accidents occur to seamen than any other class of individuals and it is consequently the best field for the study of Surgery in the Southwest.

6th. Because in consequence of its great population, its hospitals are filled with patients.

7th. Because, as the undersigned pledge themselves, students can get board at twenty-five dollars a month.

A Home Institution has already been too long wanted among us. The expense attending the acquisition of knowledge in schools at a distance from us has heretofore closed the door of science against the poor student and has caused this part of the country to be overrun with Quack Doctors, to the destruction of human life. An institution like that we are about to establish, which will bring knowledge to our doors, impart instruction at the cheapest possible rate and afford the opportunities of medical education to all who may feel inclined to avail themselves of them must lead to the advancement of Science and the rational treatment of disease by regular bred Physicians, and cannot fail, in whatever point of view it is considered, to obtain the good wishes of every philanthropist and friend of science. Besides, to the student of Medicine in the Southwest it will recommend itself by this unanswerable reason for a preference over any similar institution at a distance; it will enable him to study diseases and their treatment in the climate in which he intends to practice, and will supply him with that information which is necessary to his successful practice, and which he could not obtain except at home.

The undersigned respectfully invite the attention of students of medicine of the Southwest to the above observations and, confident of success, announce that The Lecturers of the Medical College of Louisiana will commence on the first Monday of January, 1835, and will continue for four months from that date.

Thomas Hunt, M.D. Professor of Anatomy and Physiology.

John Harrison, M.D. Adjunct.

Charles A. Luzenberg, M.D. Professor of Principles and Practice of Surgery.

J. Monroe Mackie, M.D. Secretary. Professor of Theory and Practice of Medicine.

Thomas R. Ingalls, M.D. Professor of Chemistry and Pharmacy.

Edwin B. Smith, M.D. Professor of Materia Medica.

Augustus H. Cenas, M.D. Professor of Obstetrics and Diseases of Women and Children.

Demonstrations in practical anatomy will be given daily by the Adjunct Professor of Anatomy and Physiology. Chemical lectures will be delivered twice a week at the Charity Hospital. The Hospital will be open every day for the attendance of students.

(Signed) THOMAS HUNT, M.D.
Dean of the Faculty

New Orleans, September 25, 1834.

There was considerable opposition to the founding of the new school as evidenced by letters published in the lay press at that time. The fact that the faculty was composed almost entirely of English speaking physicians (in a community in which the majority of physicians were French trained), that they were self-appointed, and that many were young was objected to by many of the local profession. One is referred to Fossier's excellent and complete review of this controversy.

The period of instruction was not long. In the original prospectus the following appeared: "To be entitled to a degree the candidate must have

Fig. 2. Josephine Hutchinson Memorial erected in 1893.

pursued the study of medicine for at least three years with his preceptor; he must have attended at least two full courses of lectures[1]; he must have passed an examination by the Faculty of the College; he must be at least twenty-one years of age; he must present no faults of character; he must submit a satisfactory thesis upon some phase of medical science." The tuition was high, approximately one hundred and fifty dollars a session. The fees were as follows: Matriculation fee, five dollars; fee for tickets for each professor, twenty dollars; demonstrator's tickets, ten dollars; graduation fee, thirty dollars.

The school was awarded its charter by the state legislature on April 2, 1835. At the first session which terminated April 27, 1835, there were eleven students. In the session 1835–36 there were sixteen students. On April 5, 1836, twelve men were awarded diplomas, which were the first degrees awarded in medicine or in science in the Southwest. In 1840 a small building was secured in the vicinity of the Charity Hospital. Prior to this the teaching had been done largely in the homes of the professors and the Charity Hospital. In 1845 through the efforts of Thomas Hunt at the time of the adoption of the new constitution for the State of Louisiana provision was made for the establishment of a State University of which the Medical College of Louisiana was to become the Medical Department of the University. A building was erected by the State and in return for the financial aid received from the State, the faculty of the medical school agreed to attend the patients at Charity Hospital without remuneration for a period of ten years. In 1847 a larger Medical School building was erected by the State at an approximate cost of forty thousand dollars, and was one of the largest and best equipped medical buildings in the United States. This building was a part of a group of University buildings located on Baronne and Common streets which were occupied until 1898 (Fig. 1). In 1844 a surgical amphitheater was erected on the grounds of Charity Hospital, half of the funds for which was contributed by the Faculty of the Medical School. In 1850 an appropriation of twenty-five thousand dollars was made by the State Legislature for the purchase of anatomical, obstetrical, physiological, surgical, pathological, and dermatological preparations, models and drawings. Wax models of skin diseases were obtained from Mr. Town's original collection at the Guy's Hospital, London. Anatomical preparations were secured from the Academy of Anatomy in Florence. The museum of these models and preparations was one of the finest and largest in America and probably equalled any in Europe. The size of the student body increased in number until in 1846 there were one hundred enrolled. In 1858 there were two hundred and seventy-six, and in 1860–61 there were over four hundred students. The activities of the medical school were suspended during the years 1862 to 1865 because of the Civil War. The College was again opened in 1865 and since then

[1]The second year consisted largely of a repetition of the first year's lectures.

Fig. 3. New Hutchinson Memorial Building completed December 1, 1930.

has uninterruptedly prospered, the total number of graduates up to the present time being 6,320.

In 1882 Paul Tulane, a resident of New Jersey of Huguenot descent, who had amassed a fortune in New Orleans in the clothing business, donated over a million dollars to found a university in order that the young white persons in the city of New Orleans might be educated. Tulane, while a boy, visited relatives in Nashville. On one occasion he went to Louisville to witness the arrival of the first steam boat from New Orleans. Upon arrival of the boat he was impressed by the large number of Louisiana planters who were bringing their sons to Kentucky schools, which was customary at that time. In the devastating reconstruction period following the Civil War such an education became impossible and it was in order that a similar education might be obtained in New Orleans that Paul Tulane gave the money, something over a million dollars—a considerable sum at that time, for the founding of the University which today bears his name. In 1884 the University of Louisiana became known as Tulane University of Louisiana, and the Medical College of Louisiana became the Medical Department of the Tulane University of Louisiana. Since this time the College of Medicine of Tulane University has maintained the policy originally intended by Paul Tulane, i.e., a Louisiana and southern school primarily for southern boys. The new Tulane University was built on St. Charles Avenue opposite Audubon Park. However, the medical school

continued in its old domicile on Baronne and Common Streets until 1893, when Mrs. Richardson, the wife of Dr. T. G. Richardson, who for years had been a valuable and loyal professor and dean of the Medical College, donated funds sufficient to erect a new medical building on Canal Street (Fig. 2). In 1906 the first two years of medicine were transferred to the campus on St. Charles Avenue, at which time another Richardson Memorial Building was constructed. The building on Canal Street, because of donations by Alexander Hutchinson after his wife's death "to increase the efficiency of Tulane Medical School and provide furthermore for a free clinic for the destitute sick of all races, colors and creeds," became known as the Hutchinson Memorial Building. This building continued to be used as the administrative offices, the research laboratories and class rooms for the two clinical years until December 1, 1930, when a new Hutchinson Memorial Building (Fig. 3) was completed on Tulane Avenue adjoining Charity Hospital. This building was made possible by a donation of one and a quarter million dollars from the General Educational Board. The building is modern in every respect, houses the administrative departments, research laboratories, class rooms, and an out patient department for the two clinical years. It is unique in the respect that the building is so arranged that the out patient teaching is conducted in individual offices. Each senior student has for his own individual use what corresponds to a well equipped private office. In the building there are one hundred and five such offices equipped with the necessary examining tables, desks, chairs, dressing cubicles, sterilizers, and laboratory facilities for routine laboratory work. The examination and the care of patients in the out patient department is done entirely by senior students under the supervision of instructors. The hospital teaching is still conducted in the great Charity Hospital which because of its wealth of material, including almost every type of lesion and morbid process, is an admirable teaching laboratory, and in the Touro Infirmary where there is also abundant clinical material.

One of the chief contributions which Tulane University has given to medicine has been the researches in vascular surgery. Warren Stone, in November, 1849, was the first to cure an aneurysm of the vertebral artery. Symthe first ligated successfully a subclavian artery, whereas the contributions of the master surgeon, Rudolph Matas, to this field of surgery, especially as regards the conservative treatment of aneurysm by endoaneurysmorrhaphy, and the transvenous suture of arteriovenous aneurysm, are too well known to need further elaboration.

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THE SURGEON'S LIBRARY

REVIEWS OF NEW BOOKS

THE third volume of Curtis' *Obstetrics and Gynecology*[1] is just off the press. The first two volumes have been reviewed by W.W. Chipman and Irving Cutter. The book before us is opened with a section on "Displacements and Relaxations" to which Baer, Farrar, and Ward have contributed. It is prefaced by a short introductory chapter by Curtis who warns against the tendency to overcorrect injuries sustained in childbirth, and stresses the value of reconstruction without undue tension, fixation, or rigidity.

In the section on "Disturbances of Function," C. Jeff Miller presents a well written chapter on dysmenorrhœa which, for practical reasons, he is inclined to consider as a disease though actually it is merely a symptom. The various types of uterine hæmorrhage, amenorrhœa and scanty menstruation, and, finally, the disturbances of the menopause are discussed by Novak. The subject of sterility has been entrusted to Rubin to whom we are indebted for a most interesting chapter. Reis contributes an instructive discussion of various sex problems such as vaginismus, dyspareunia, sterilization.

The following section on "The Endocrines in Gynecology and Obstetrics" is probably the best that has yet been written in the English language. Allen, of the Allen-Doisy test fame, Corner, Philipp E. Smith, and Engle have divided the field to which they themselves have made such notable original contributions, and discuss the ovarian hormone, the corpus luteum, and the anterior pituitary hormone, respectively; and the whole problem is gathered up, as it were, in a chapter on gynecological endocrinology by Novak. That this writer has been able to present the vast material concisely and yet exhaustively in only 27 pages, is but another proof of his masterly grasp of the subject.

The next section comprises a number of unrelated topics. Keene and Kimbrough write on endometrioses which they consider unreservedly in the light of Sampson's explanation of transtubal endometrial transplantation, though they admit that in a few instances inflammatory, congenital, or metaplastic factors may be at work. Now that this controversial subject has already produced an immense and at times confusing literature, this chapter should prove particularly helpful, and, as to treatment, it seems especially appropriate to underscore the contention of the authors that "it is wise to err on the side of conservation, the disease being essentially one in comparatively young women." A chapter by Anspach on ectopic pregnancy in which he emphasizes the diagnostic value of the various tests of pregnancy, is followed by a scholarly discussion of leucorrhœa by C. H. Davis. We may have deluded ourselves in the belief that genital fistulæ, that bane in the days of Marion Sims, have no longer their former practical importance; but "with the increase in the number of complicated pelvo-abdominal and obstetrical operations the rare fistulæ are becoming more common," and for this reason Rawls' chapter on the subject will be a valuable reference. Hyperplasia and (true) endometritis are competently presented by Novak. In the dissertation by Lynch on backache it is important to note that pelvic disorders were responsible for this symptom in fully 49 per cent of his cases, as proved by careful follow-up investigation. Frequent assertions to the contrary notwithstanding, the chronic congestion that usually occurs in a retroflexed uterus with prolapsed ovaries, may cause backache even in the absence of inflammatory complications, and the pain can be cured by surgical means. The reviewer is quite in accord with this attitude though he would prefer a trial with pessaries prior to any operation.

The succeeding section on "Other Gynecological Diseases and Symptom Complexes" is headed by a chapter on lesions of the cervix wherein Holden gives a very clear presentation of this subject and goes into satisfying details regarding treatment. Richard R. Smith adds a short chapter on eversion of the meatus urinarius and urethral caruncles. Then follow four chapters on diseases of vulva and vagina from the authoritative pen of Taussig, a discussion on gynatresia by Gordon, on inversion of the uterus by Irving, and one on the clinical aspects of congenital malformation by Masson and Rieniets.

The last section of the work contains numerous "special topics." Curtis contributes a chapter on gynecological history and examination, and one on the early months of pregnancy from a gynecological standpoint. Counseller writes on the relations of appendix and large bowel to gynecology, a subject which is naturally of great practical value to us. "Urinary Tract Problems in Gynecology" are treated separately by Hunner and by Danforth. Case offers a large chapter on obstetrical and gynecological roentgenography, and Burnam follows

[1] OBSTETRICS AND GYNECOLOGY. Edited by Arthur Hale Curtis, M.D. Vol. iii. Philadelphia and London: W. B. Saunders Company, 1933.

him with an exhaustive treatise on radium. The subject of blood transfusion is dealt with by Fitzgerald and Koch, that of pre-operative problems by Gardner. Anæsthesia is Towell's topic, and hypnotics and analgesics are discussed by Maxwell. Curtis furnishes a chapter on operative management and postoperative care which reflects his rich experience. Though for lack of space the various subjects in the book could be mentioned only in the briefest outline, the reviewer cannot refrain from quoting the author's dictum that the old adage "Haste makes waste" should in gynecological surgery be paraphrased as "Haste makes morbidity and mortality." Of particular interest are the discussion by Pollock on neuropsychiatry in relation to gynecology and obstetrics, and the closing chapter of the book in which Middleton writes on the connections between internal medicine and obstetrics and gynecology. In these two chapters bridges are built between our specialty and mother medicine.

The mere recounting of the contents of this volume can not do full justice to the excellence with which each of the multitudinous topics has been handled. The editor has, indeed, known how to choose his collaborators. As Chipman pointed out in these columns a few months ago, many of these chapters are real monographs. This necessarily involves a certain amount of overlapping, but so splendid has been the co-operation of editor and associates that repetitions have been reduced to a minimum. I do not pretend to have studied all of the 1200 pages of this volume. That would have been physically impossible in the time set for me for this review. But in going through chapter after chapter I have found practically nothing that could seriously be questioned, and very little that seems to have been omitted. There are 1664 illustrations in this one volume. Because of the prohibitive cost of reproduction in color, they are almost altogether in black and white. The paper, however, is of such good quality that even the photomicrographs come out perfectly clear.

Each volume has its own index, and, in addition, there is a separate General Index of 137 pages to all three volumes, which will be found extremely convenient.

Now that the complete work is before us, it is possible to evaluate more fully the significance of this undertaking. It is for the first time that the profession in English speaking countries has had access to a reference work of this size and scope. We are not dealing with a textbook sufficient for the needs of undergraduate instruction but with a real encyclopedia, a summary of knowledge which will be of importance alike to the advanced student, to the practitioner in search of guidance, and to the experienced specialist. As such it is a credit to American gynecology and obstetrics of which we may justly be proud. But beyond any national limit, it is a monument to our specialty itself. It proves, if further proof were needed, that obstetrics and gynecology are indivisible; and the bibliographic references at the end of each chapter show that the sources of our knowledge come from all the world and have nothing to do with political or geographical frontiers. The eighty contributors have done their best to present the present status of this knowledge. But in our fast moving time new truths are found constantly, and former views are apt to be revised. To prevent this work from ever becoming obsolete, we are promised that every five or eight years a new edition will embody all the progress made in the meantime so that this *Obstetrics and Gynecology* will steadily advance with advancing generations.

Editor and publisher deserve our thanks for their great achievement. GEORGE GELLHORN.

THE 350 page monograph[1] by Jarcho is the first attempt in English to describe the part which the pelvis plays in modern obstetrics. The author places particular emphasis on pelvimetry and especially on roentgenological mensuration.

This emphasis has led the author away from sound clinical judgment. The statement on page 9 that "practitioners unskilled in mensuration have come to depend upon the dangerous test of labor" must not go unchallenged. A test of labor, properly used, will always remain the final test of any given pelvis. Every obstetrician with experience has seen pelves, with measurements indicative of dystocia, permit rapid and uncomplicated delivery. The size of the fetal head, the fetal attitude of flexion or varying degrees of deflexion, the position of the fetal head at the pelvic inlet, etc., all play rôles in the ultimate outcome of any given labor. Pelvic mensuration alone cannot give a definite prognosis except in the few instances of absolute disproportion. The borderline pelvis must have a test of labor for proper obstetrical evaluation. The author himself agrees with this thought on page 111 where he states that "a test of labor may be allowed before cæsarean section is decided upon." Furthermore, a properly conducted test of labor is never dangerous. This is obvious to every experienced obstetrician. Jarcho must feel that it is safe or he could not recommend it as he does in the text of the book.

The author has gathered together a considerable bibliography and quotes freely from the literature. He has, unfortunately, been careless in several instances in failing to give credit to other workers in this special field. The method of lateral pelvimetry on page 269 has been described previously by Thoms in the *New England Journal of Medicine* for 1929, volume 200, page 829. The author's method of roentgen-ray cephalometry on page 277 is practically that originally described by Thoms in 1930 (J. Am. M. Ass., xcv, 21). Jarcho's method of roentgen-ray pelvimetry, originally reported in the *American Journal of Surgery* for November, 1931, differs from that of Thoms (J. Am. M. Ass., 1929,

[1] THE PELVIS IN OBSTETRICS; A PRACTICAL MANUAL OF PELVIMETRY AND CEPHALOMETRY INCLUDING CHAPTERS ON ROENTGENOLOGICAL MEASUREMENT. By Julius Jarcho, M.D., F.A.C.S. New York: Paul B. Hoeber, 1933.

xcii, 1515) only in that Jarcho places the patient in the sitting position rather than in the semi-recumbent position. Later in the work, the author reverses himself and states that he places the patient in the semi-recumbent position.

The book is profusely and well illustrated but the same carelessness noted above, has caused the author to fail to give due credit to Sturmdorf for illustration 55 on page 171. Sturmdorf first described the measurement of the lumbosacral index in SURGERY, GYNECOLOGY AND OBSTETRICS in August, 1931, xliii, 209.

The reviewer cannot agree with the statement that "the fundamental cause of difficult labor is that the child's head and the mother's pelvis do not fit" nor to his concluding statement that "roentgenological pelvimetry now offers a practical and exceedingly exact means of determining the pelvic diameters."

It is to be hoped that a second edition will include the necessary changes as there is a definite place in obstetrics for a work such as this.

RALPH A. REIS.

IN Swanberg's *Radiologic Maxims*,[1] the material is presented in short, terse statements, usually 2 to 6 lines in length, each dealing with a particular phase of radiological diagnosis. Of the 122 pages, 64 are devoted to roentgen diagnosis and the remaining 58 to radiation therapy. The first few pages deal with general radiology. The second section on roentgen diagnosis covers bone pathology, the chest, the gastro-intestinal tract, including the gall bladder, the genito-urinary tract, obstetrics and gynecology, and the skull. Roentgen therapy, radium, and ultraviolet rays are adequately taken care of.

Included in each section dealing with a particular branch of diagnosis or therapy are short quotations or statements by prominent, well qualified physicians who are not radiologists, but who are highly trained in that particular field.

The maxims presented deal not only with what can be expected of a roentgen examination or radiation therapy, but in many instances present the indication for such an examination or therapy.

E. E. BARTH.

THE Cyclopedia of Medicine[2] is to consist of 12 volumes of material, arranged alphabetically, which "will embrace virtually the entire system of practical medicine and surgery with a complete survey of the specialties and medical sciences." Dr. George M. Piersol is editor-in-chief and he has selected a group of associate editors chiefly from the Pennsylvania medical schools to assist him. Much of the material is supplied by other associates, also selected because of their pre-eminence in the various fields of medicine and medical sciences, not only from most of the great medical schools of the United States and Canada but also from many of the countries of Europe, Central and South America. The volumes are of a convenient size (7 by 10) of 700 to 1000 pages, in attractive flexible green bindings. The material is well printed on substantial paper. The disease entities have been discussed in an orderly way from the standpoint of etiology, pathology, symptomology, differential diagnosis, and treatment. The operative technique together with preoperative and postoperative management has been emphasized in the care of the surgical disorders, gynecology, obstetrics, ophthalmology, and otolaryngology. An example of the care with which the editor has prepared this set is indicated by securing such splendid sections as infections of the hand, backache, bacteriology, immunology and others.

The first volume starts with the topic "Abdomen, acute," and a good differential diagnosis ends up with a well balanced consideration of the problem. The individual discussion of appendicitis comes at the end of the volume. Drugs both old and new, such as aloes, allonal, and avertin, are discussed from the aspect of the pharmacologist. Anæsthesia, amputation, and animal extracts are examples of subjects appearing in this alphabetical arrangement which are well treated. To date only the first 7 volumes have been published but the reviewer feels that if these volumes are an index, the cyclopedia will prove to be very useful to the large number of physicians not only in general practice but to those interested in special fields. Dr. Piersol states that it is planned to bring out a supplement from time to time to cover the rapid advances and constant changes taking place in medicine. M. HERBERT BARKER.

IN a volume of seven hundred pages with five hundred illustrations, Bland presents a textbook[3] of obstetrics which had its origin in a set of obstetrical notes and tables that had been prepared and used for teaching purposes by the author. The illustrations contained in this text are well done and are graphic. The subject matter is well presented and one finds it easy reading. There is a definite departure from the arrangement found in most standard textbooks, in that Bland treats of all of the pathology of pregnancy—antepartum, hæmorrhage, ectopic gestation, toxæmias, etc., and the treatment of these conditions—before normal labor is considered. It would seem that for the beginner to have a true appreciation of the rationale of various methods, of the treatment of placenta prævia, for example, he should have some knowledge of the mechanics of normal labor.

In the chapter on "Symptoms and Diagnosis of Pregnancy," a rather complete list of metabolic,

[1] RADIOLOGIC MAXIMS. By Harold Swanberg, B.Sc., M.D., F.A.C.P. With a Foreword by Henry Schmitz, A.M., M.D., LL.D., F.A.C.R., F.A.C.S. Quincy, Illinois: Radiological Review Publishing Company, 1932.

[2] THE CYCLOPEDIA OF MEDICINE. By George Morris Piersol, B.S., M.D., editor-in-chief, and Edward L. Bortz, A.B., M.D., assistant editor, Charles E. de M. Sajous, M.D., LL.D., Sc.D., founder and first editor, vols. i, ii, iii, iv, v, vi, vii. Philadelphia: F. A. Davis Co., 1933.

[3] PRACTICAL OBSTETRICS FOR STUDENTS AND PRACTITIONERS. By P. Brooke Bland. Assisted by Thaddeus L. Montgomery, M.D. Philadelphia: F. A. Davis Company, 1932.

chemical, and biologic tests is described. The importance of the Aschheim-Zondek test in the early diagnosis of pregnancy is properly stressed. In the same chapter under the discussion of X-ray in the early diagnosis of pregnancy, Bland states that X-ray as a diagnostic aid is not available until after the sixth month. This statement is repeated in a subsequent chapter. This is very surprising and contrary to the general consensus of opinion in regard to the time at which fetal skeletal outline can be demonstrated by roentgenography.

In the chapter on "Antepartum Hemorrhage," the author presents a very graphic description of placenta prævia by illustrations. However, a departure from conservative, operative obstetrics is noted when manual dilatation of the cervix is mentioned in connection with the treatment of placenta prævia.

Tables of differential diagnosis are to be found throughout the book which deal with the more common complications of pregnancy and labor and should be rather helpful to students. The Hillis impression method of estimating disproportion between the fetal head and the maternal pelvis is described and this maneuver in experienced hands is a very valuable procedure in the last weeks of pregnancy when a disproportion is suspected. A rather comprehensive appendix of referred reading is included in the book.

The reviewer feels that this textbook will be valuable for the students of Bland as it will illustrate and augment his particular lectures and should be a worthwhile book for the obstetrician's library.

CHESTER C. DOHERTY.

THE authors present in the 1932 volume of *The Year Book of Radiology*[1] a résumé of the most important articles on radiology that have appeared in medical literature the past year. The abstracts presented are concise but, nevertheless, give the essence of the article. In the compilation of the various articles, the authors present 493 illustrations, which are well reproduced and which add greatly to the value of the book. The majority of the illustrations are reproduced from the original roentgen films or photographs. The articles used are not only those appearing in radiological journals of America but are drawn from the many periodicals in the field of medicine which deal with radiology. The authors have also drawn from the great university clinics of Europe. This enhances the volume greatly, especially to the physician who is not conversant with foreign languages.

The volume covers the field of roentgen diagnosis, roentgen therapy, and radium therapy. Important advances have been made in the newer phases of roentgen diagnosis, such as encephalography, ventriculography, intravenous urography, pelvimetry, hepatosplenography, and studies of the heart and aorta. In the field of gastro-intestinal diagnosis tremendous advances have been made by the revised methods and the various agents employed. The use of opaque material in small quantities followed by the injection of air has opened a field of great possibilities. The literature dealing with hepatosplenography, by means of thorium dioxide, is compiled and the procedure is gradually gaining favor.

In roentgen therapy the *r* unit is being used almost exclusively. This standardization of a unit of dosage has been an important step in roentgen therapy. The newer equipment providing for much higher voltage, which will deliver a quantity of X-rays equal in quality to the γ-rays of a four gram pack, is enthusiastically praised by some advocates. Numerous communications dealing with radium bomb or massive radium pack type of therapy are presented. This type of treatment is available only in the endowed institutions at present, and the results are being awaited with considerable interest. It is highly praised by workers in Stockholm, Paris, and parts of the United States, but the English have found the four gram pack of little value. The method of Coutard in treating malignancy of the upper respiratory tract is being quite generally used both in America and in Europe, and is being accepted as the method of choice in the treatment of these lesions.

The volume should prove very valuable to the busy physician who has not the time to cull through the vast amount of material presented, and it should serve as a working reference, acquainting him with the more recent advances in radiologic science. Although the reviews are often brief, the articles used having already been presented in condensed form, the project and the satisfactory manner of presentation are to be highly commended and the volume unreservedly recommended.

EARL E. BARTH.

IN the preparation of his book, Dr. V. Meisen has covered the whole field of varicose veins in detail.[2] At the same time he has not been verbose in the work. He has drawn from his extensive experimental work at the Royal Veterinary Hospital both for the pathology of varicose veins and in a study of the pathological reactions present following the injection treatment of same. He discusses very clearly the association of varicose veins to varicose ulcers as well as to the other complications and end-results often found present. His technique of the treatment is simple and clearly stated though not as carefully worked out as has been done by some of the American physicians and authors. The book is well illustrated and is very well published. It is without question the best book on this subject published abroad.

H. O. MCPHEETERS.

THE authors of the book on postural defects[3] are well qualified Yale University men. One is pro-

[1] THE 1932 YEAR BOOK OF RADIOLOGY. DIAGNOSIS. Edited by Charles A. Waters, M.D. THERAPEUTICS. Edited by Ira I. Kaplan, B.Sc., M.D. Chicago: The Year Book Publishers, Inc., 1932.

[2] VARICOSE VEINS AND HÆMORRHOIDS; AND THEIR TREATMENT. By V. Meisen, M.D. With a Preface by Aug. Krogh, Ph.D. Copenhagen: Levin & Munksgaard, 1932; London: Oxford University Press, 1932.

[3] THE DIAGNOSIS AND TREATMENT OF POSTURAL DEFECTS. By Winthrop Morgan Phelps and Robert J. H. Kiphuth. Springfield, Illinois and Baltimore, Maryland: Charles C. Thomas, 1932.

fessor of orthopedic surgery; the other is assistant professor of physical education. They treat the subject in an interesting manner. The book is the outgrowth of a study of the male students of four institutions. One chapter deals entirely with the statistical report of the material drawn from examinations of the students of all age periods. The first two chapters deal in a fascinating manner with evolutionary and environmental influences on posture.

The evolutionary trend of posture from the primordeal organism through fish, amphibian, reptile, primitive mammals, tarsoid primates, ancient anthropoids, prehuman, and finally human stages is presented. In the development of earth-living animals the suspension posture occurring in tree-living adaptations and the supportive posture in ground-living adaptations is presented as being directly influenced by gravitational force. The environmental influence and its effect on the final adult posture is traced from intra-uterine and babyhood influences through the pre-school and pre-adolescent periods into the adolescent and young adult stages.

Normal posture is defined as the average of a large number of postural examinations under the same conditions. There is the ideal normal group, normal and individual or habitual normal postures. No attempt was made to judge type normal because the authors feel that the judgment of posture should depend, not on the question of slenderness or obeseness, but upon the mechanical efficiency of the position.

Body mechanics from the standpoint of the individual joint is anatomically presented in a scientific manner. The mechanical influence of one joint upon another and the effect on the posture of the whole body when individual joint mechanics vary from the normal is carefully analyzed.

Posture examination comprises a large chapter and deals with the variations or deviations from the normal of the individual joints with structural or functional changes. The importance of recording the degree of variation in order to note subsequent favorable or unfavorable changes with therapy is stressed.

Posture in physical education has undergone radical changes from the traditional routines of the past. The tendency of individual study and exercises has resulted in a new method of physical education.

A complete chapter on corrective exercises is excellently presented with a detailed explanation of how to perform each exercise.

The book is well illustrated with photographs, diagrams, and anatomical sketches.

No one treating posture or teaching physical education should be without this book. Its appeal is greatest to orthopedists, physical therapists, and teachers of physical education. PHILIP LEWIN.

AS its name implies, Brooke's *Shorter Orthopædic Surgery*[1] is a very condensed text covering the field of orthopedic surgery. The text is divided into anatomical subjects: chapters consisting of those on hip joint; knee joints; foot and ankle joints; shoulder joints; hand and wrist; the neck, spine, and pelvis. In addition to these, there are chapters on arthroplasty and amputation, and one on plaster-of-paris technique. The important phases of most of the subjects counted as orthopedic surgery are touched upon in a very brief manner. The book is quite well illustrated with photographs, roentgenograms, and drawings. There is no general consideration of disease entities, other than as they involve the specific joints.

In the main, the treatment outlined is conservative, one exception being that of the fibular transplant to replace the resected head of the humerus in tuberculosis of the shoulder joint.

As a handbook of orthopedic surgery, this book is acceptable but it can in no way displace the more extensive standard texts now available.

FREMONT A. CHANDLER.

THE results of various surgical procedures on the pelvic sympathetic nervous system in such gynecological conditions as pelvic neuralgia due to carcinoma of the cervix, so called essential pelvic neuralgia and dysmenorrhœa, dyspareunia, and vaginismus, cystalgia and functional disorders of the urinary bladder, leucorrhœa and intractable hydrorrhœa, disturbances of the sexual sense, pruritus vulvæ, amenorrhœa, aplasia, and trophic changes of the genital organs, are presented by Gaston Cotte in his *Chirurgie du Sympathique Pelvien en Gynécologie*.[2]

The conclusions are drawn both from his own experience and from that reported in the literature of the subject.

Of the various surgical procedures which have been used in the disturbances mentioned, resection of the superior hypogastric plexus seems to be, according to the author's experience, the procedure of choice. The technique of the procedure, advocated by Cotte in 1924 for the first time is described in detail.

The author finds reason for attacking the sympathetic nervous system to relieve these various pathological conditions in the assumption that by section of the sympathetic nerves the organs innervated by them are cut off from the more highly situated sympathetic centers, and that the visceral plexuses are thus liberated. Thus the pathways for pathological reflexes which may originate in a diseased organ, and which in turn might produce such disturbances as dysmenorrhœa, hydrorrhœa, pruritus vulvæ, kraurosis vulvæ, etc., are divided. According to the author, peri-arterial sympathectomy produces not only a hyperæmia of the denervated organs, but a modification of the status of abnormal reflexes.

There is occasionally also a histological basis for surgical intervention upon the sympathetic nerves. For instance, in 31 cases of essential dysmenorrhœa, not associated with apparent lesions of the genital

[1] A SHORTER ORTHOPÆDIC SURGERY. By R. Brooke, M.S., F.R.C.S. New York: William Wood and Company, 1932.

[2] CHIRURGIE DU SYMPATHIQUE PELVIEN EN GYNÉCOLOGIE. By Gaston Cotte. Paris: Masson et Cie, 1932.

organs or pelvic peritoneum, microscopic examination of the superior hypogastric plexus revealed in 16 cases definite signs of a neuritis; in 3 cases the nerves were found sclerotic and in 1 case the plexus presented a neuroma; in 2 cases neuritis of the plexus was concomitant with a cellulitis in the neighborhood. In 9 cases the plexus was found to be histologically normal.

Care must be used that the sympathetic nervous system be approached at the proper site; in essential pelvic neuralgia with the pain located chiefly in the region of the uterus, spreading thence toward the anus, coccyx, and perineum, the nerve to be divided is the superior hypogastric plexus; in pain mainly in the lumbar region the procedure of choice is resection of the nerves entering the hilus of the ovary, or, if the procedure is technically difficult, a respective ramisection; section of the superior hæmorrhoidal nerves, in addition to resection of the superior hypogastric plexus, is indicated in cases in which the neuralgic pain is chiefly of anorectal location.

The author further emphasizes the point that the operation upon the pelvic sympathetic nerves in gynecological conditions be done only to relieve complaints or symptoms which can be directly attributed to the function or dysfunction of, and not for conditions obviously not concerned with, the sympathetic nervous system.

A combined operation on the pelvic sympathetic nerves and the genital organs or the adnexa, however conservative the procedure may be, makes it very difficult to establish the exact part played by each procedure in the relief of a given pathological condition. Therefore, the conclusions drawn from the author's observations are not always entirely convincing; for instance, while in 91 cases of essential dysmenorrhœa, which was either the only symptom present or was associated with leucorrhœa, dyspareunia, frigidity, constipation, enterocolitis, dysuria, etc., the treatment is listed as successful without any additional operation upon the adnexa, we find actually only 3 cases in which the treatment was resection of the superior hypogastric plexus alone; in the 88 other cases this procedure was combined with appendectomy, ligamentopexy or even, occasionally, by enucleation of a follicular cyst or partial resection of an ovary.

The lack of exact anatomical and physiological data concerning the sympathetic innervation of the various pelvic organs is another reason for our inability to accept without reservations the conclusions arrived at as to the value of operations upon the sympathetic nerves in conditions of a gynecological nature.

The participation of the sympathetic nervous system in these various disturbances might occasionally suggest that operation would be of value in relieving the distress. However, a thorough study of the problem, both from the anatomical and experimental point of view is needed before exact indications for operation can be determined and results evaluated.

G. CHOROBSKI.

THE five-hundred-page monograph on fractures of the extremities[1] by René Simon, professor of the Faculty of Medicine of Strasburg, is divided into three parts. The author first considers fractures in general from the standpoint of biology, etiology, and anatomy. He also describes the general symptoms and methods of treatment. A chapter is devoted to problems of the union of fractures and the treatment of compound fractures in general. The second part of the book covers the consideration of fractures of the upper extremity, and the third part, fractures of the lower extremity, including those of the pelvic girdle.

The material is presented in concise form without lengthy bibliography or controversial opinions. In general, the author presents *his* concepts of the modern knowledge of fractures. He has no unusual or radical theories or methods to present. His consideration of fractures of the upper and lower extremity are well classified, according to the bone involved and the particular parts of the bones. He presents the various methods with their advantages and disadvantages, as well as their application to particular types of pathology.

The book contains neither photographs nor X-rays; however, it is remarkably well illustrated by diagrammatic sketches, portraying the author's concepts of the bone pathology.

In summary, it may be said that while this book adds nothing particularly new in principle to our knowledge, it gives an adequate conception of the French viewpoint of fractures of the extremities and advocates open reduction more frequently with a more general use of plates and screws.

ARTHUR H. CONLEY.

THE third volume of *The Practice of Medicine*,[2] of the series edited by George Blumer, appears about a year after the first two volumes. The author's preface clearly states the purpose and essential points emphasized in this volume iii. "It is the purpose of this volume to present the material ordinarily covered in the standard textbook on internal medicine, diseases of the nervous system excepted. The underlying idea has been to give a lucid account of the present knowledge of each disease which is at the same time authoritative, concise, sufficiently comprehensive for all practical purposes, and free from confusing discussions of unsettled though possibly interesting problems. There has been an attempt where possible to emphasize the relation of trauma to internal disease, a field which has been brought into the limelight by workmen's compensation laws. The reader will perhaps find that the emphasis on various diseases is not exactly that to which he is accustomed. With the passage of time, some diseases become less important, while others arise or assume more importance. Typhoid fever, for ex-

[1] LES FRACTURES DES MEMBRES; CLINIQUE ET THÉRAPEUTIQUE. By René Simon. Paris: G. Doin & Cie, 1933.

[2] THE PRACTITIONERS LIBRARY OF MEDICINE AND SURGERY. Vol. iii. Practice of Medicine. New York and London: D. Appleton and Company, 1933.

ample, is less extensively treated than in many of the other treatises, but typhoid fever is a disappearing disease. Tularæmia and undulant fever have a good deal of space assigned to them; they are diseases which are becoming more prevalent and therefore more important to the general practitioner. In the same way the section on allergic diseases is much fuller than is usual in a work of this kind, but, here again, we are dealing with a new field which is constantly growing and assuming greater and greater importance. In this volume, as in the preceding ones, an attempt has been made to make the material easily available." Dr. Blumer has selected various groups of men to assist in creating this series. Many of the contributors to volume iii are relatively young men but they are men especially interested in the specific subject assigned to them and they are active investigators in their respective fields. Some of the assignments appear rather broad for an occasional contributor so that some parts of some subjects are rather weakly treated. Joseph Moore outlines the section on syphilis with pertinent comments from his experience upon points of question to all treating syphilis. He outlines treatment so that good management is immediately visualized by those less familiar with the various problems arising. The author discusses undulant fever, staphylococcal infections, rickettsial infections, food poisoning, diseases of the peritoneum, omentum, mesentery, mediastinum, and diseases of the diaphragm. He includes poisoning from bites of reptiles and insects. A definite attempt is made to include many subjects met in ordinary practice which are not found in the standard texts. On the whole the material is nicely arranged, well written, and a good bibliography follows each subject. M. HERBERT BARKER.

THE book by Pusey entitled *The History of Dermatology*[1] contains nine chapters with thirty-two illustrations and an historical index. It is the only history of dermatology in English and represents, in the main, the story of the masters in that field and in medicine in general, in so far as it is related to dermatology, from 3000 B.C. to the beginning of the twentieth century.

In tracing the gradual development and progress of dermatology through the centuries, in the different countries, the author identifies these with definite landmarks of advancement in science and culture; and in that sense, the monograph may be said to reflect the history of civilization.

The flowing, literary and narrative style of the author conveys to the reader a vivid, human portrayal of the pioneers in dermatology. The book is not merely a recital of facts and events of interest to every disciple of Æsculapius, but provides an evening of entertainment and will be enjoyed by every physician.

The historical index of dermatology in the back of the book, preceding the general index, is a valuable asset to every dermatologist in that it furnishes a bibliography of skin diseases with accessible references for the study of the subject.

On the whole, it is a book very much worthwhile. EDWARD A. OLIVER.

THE book, *Infections of the Hand*,[2] by Allen B. Kanavel is radically changed and improved in its new sixth edition. The subject is discussed under four parts in an effort to simplify the presentation and make it conform more nearly to the usual textbook style.

Part I of the book is concerned with the anatomy of the hand and forearm. Many excellent cross sections of the hand and forearm demonstrate and clarify the anatomical relationships of these structures. The relation between the synovial sheaths and major fascial spaces is stressed and demonstrated by drawings and X-rays from the experimental studies obtained by the author following injection of these structures. The illustrations from these injections show the avenues through which infections of the hand may spread. The general principles peculiar to infections of the hand are given. Part I, therefore, covers the anatomical and experimental considerations as a group, unlike the previous editions in which they were intermingled with the clinical problems.

Part II considers the localized infections and clinical entities exclusive of lymphangitis, major fascial space and tendon sheath infections. Considerable new material gathered from the recent work of the author and his associates has been inserted into this part. The additions include the peculiar course of infections from bites and injuries from teeth, the pathology and treatment of metacarpophalangeal joint infections, of gangrenous infections, of injuries from indelible pencils, of cattle hair and other peculiar infections.

Part III gives the diagnostic factors and treatment of the three severe common types of infection of the hand, lymphangitis, tenosynovitis, and major fascial space infection. The signs, symptoms, diagnosis, and treatment of these infections are very appropriately classified and discussed under eleven chapters. The author emphasizes the fact that two lesions, lymphangitis and suppurative tenosynovitis, are often unrecognized and improperly treated. He warns against hasty incisions for lymphangitis and urges early recognition and treatment of suppurative tenosynovitis. Frequent reference is made to the anatomical and experimental studies of Part I in discussing the spread and treatment of these infections. Illustrations are included showing the location of the various incisions made for infections of the tendon sheaths and forearm extensions.

Part IV consists of five chapters covering complications, sequelæ, and after-treatment of infec-

[1] THE HISTORY OF DERMATOLOGY. By William Allen Pusey, A.M., M.D., LL.D. Springfield, Illinois and Baltimore, Maryland: Charles C. Thomas, 1933.

[2] INFECTIONS OF THE HAND; A GUIDE TO THE SURGICAL TREATMENT OF ACUTE AND CHRONIC SUPPURATIVE PROCESSES IN THE FINGERS, HAND AND FOREARM. 6th ed. By Allen B. Kanavel, M.D., Sc.D. Philadelphia: Lea and Febiger, 1933.

tions of the hand. The present edition includes a more detailed description of the many new splints used by the author and his associates. The author emphasizes the importance of maintaining the "position of function" throughout the treatment of infections of the hand. In the position of function "the hand is in dorsal flexion at the wrist at an angle of 45 degrees, the phalanges at the metacarpophalangeal and phalangeal joints should be flexed to the same angle and, most important, the thumb should be abducted from the palm, adducted toward the ulnar side of the hand and rotated so that the flexor surface of the thumb is opposite the flexor surface of the index finger."

This new edition of *Infections of the Hand* remains the masterpiece and authority on the subject. It is a distinct improvement over the earlier editions in that its organization and presentation make this rather difficult subject easier to read, understand, and assimilate. The book is indispensable to the student, general practitioner, and, above all, to the surgeon. It cannot be too highly recommended.

ELLIOTT C. CUTLER

THE first edition of Aschheim's well known monograph on the diagnosis of pregnancy from the urine was out of print shortly after its appearance.[1] The second edition is enlarged and rearranged so as to include further investigations of the author himself as well as the results of other investigators who are working along the same lines.

The final work along this line has not, of course, been done. Much remains to be clarified before the subject is a completed one. Nevertheless, this monograph is distinctly worth while because it carries the work up to the present moment. RALPH A. REIS.

[1] DIE SCHWANGERSCHAFTSDIAGNOSE AUS DEM HARNE; PRAKTISCHE UND WISSENSCHAFTLICHE ERGEBNISSE. By S. Aschheim. 2d ed. thor. rev. Berlin: S. Karger, 1933.

THE book by Maingot, *The Management of Abdominal Operations*[2] describes the procedures which he uses in his practice. It is obviously intended, as he himself says in the preface, for internes and for the general practitioner who only occasionally comes in contact with the management of abdominal operations. The descriptions are concise and clear, but very brief in order to enable the author to embody the entire subject in the small handbook.

The idea is excellent. The need for just such a treatise is very definite; the present textbooks on pre-operative and postoperative management are altogether too voluminous to be used for ready reference by the busy interne. The book naturally is dogmatic; there is not space for a review of other people's opinions. Because of this dogmatic phase, the book will probably find disfavor with many surgeons whose practice differs from that of Dr. Maingot, furthermore there will be a limitation in its value for use by the interne for just this reason. Naturally, in a small handbook, such as this present volume, it is impossible to cover the entire subject and the author has picked such conditions as he evidently thinks are the most important. Excellent as the book is, it is very probable that the difference in the author's technique from that which may be practiced in other established institutions, will interfere to a certain extent with its general acceptance. However, the reviewer does feel that it will be of great service to the physician who finds himself in charge of abdominal cases of a surgical nature

RALPH BOERNE BETTMAN.

[2] THE MANAGEMENT OF ABDOMINAL OPERATIONS. By Rodney H. Maingot, F.R.C.S.(Eng.). New York: William Wood & Company, 1932.

BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

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Contains Two Indexes for Volume LVII: [1] Original Articles; [2] Abstracts

VOLUME LVII DECEMBER, 1933 NUMBER 6

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EDITORIAL AND BUSINESS OFFICES: 54 East Erie St., Chicago, Illinois, U. S. A.
IN GREAT BRITAIN: 8 Henrietta St., Covent Garden, W. C. 2, London, England.

Published Monthly and Semi-Monthly in February. Annual Subscription: United States and Canada, $12.00; Foreign, $14.00.
Copyright, 1933, by The Surgical Publishing Company of Chicago.
Entered as second-class matter January 14, 1931, at the postoffice at Chicago, Ill., under the Act of Congress, March 3, 1879.

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